

APPENDIX D

DESIGN SPECIFICATIONS



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SECTION 01000  
GENERAL REQUIREMENTS

1.1 SECTION INCLUDES

- A. Summary.
- B. Price and payment procedures.
- C. Administrative requirements.
- D. Quality requirements.
- E. Temporary utilities.
- F. Temporary facilities.
- G. Vehicular access.
- H. Temporary barriers and enclosures.
- I. Temporary controls.
- J. Product requirements.
- K. Execution requirements.

1.2 SUMMARY

- A. Location: The Site located at 6100 Campground Road in Louisville, Kentucky.
- B. Access to the Site:
  - 1. Access to the Site is available from Campground Road through OWNER's entrance.
  - 2. Make arrangements with the authorities having jurisdiction for the movement of material and equipment to and from the Site over public roadways.
- C. Scope of Work: The Works to be performed under the Contract consists of South Landfill/ Curtain Area Interim Corrective Measure and associated work for Atkemix Ten Site in Louisville, Kentucky.
- D. Description of Work: Work includes, but is not limited, to the following:
  - 1. Project startup including mobilization to the Site.
  - 2. Development, implementation, and maintenance of a Site-specific Health and Safety Plan.
  - 3. Provision and maintenance of temporary facilities and controls.

4. Removal of designated Site fencing.
  5. Implementation and maintenance of the Sediment and Erosion Control Plan.
  6. Soil/slag excavation and consolidation for Area 1, Area 2, Area 3A, Area 3C, Area 4, Area 5, and Area 6.
  7. Removal of riprap swale in Area 3.
  8. Backfilling to full depth with imported fill, including 4 in topsoil for Area 1, Area 2, Area 3C, Area 4, Area 5, and Area 6.
  9. Construction of multi-layer cap in Area 3A, Area 3B, and South Landfill Capping Area.
  10. Surface water drainage for all graded and modified areas.
  11. Construction of new access road.
  12. Installation of new culvert in Area 3.
  13. Construct new swale in Area 3.
  14. Construction of new swale in Area 4.
  15. Installation of new fencing and gates.
  16. Restoration of areas affected by the Works.
  17. Demobilization and closeout.
- E. Contract Times: The Works shall be completed by CONTRACTOR according to the following schedule:
1. Commencement of Works: Within 7 days after the date of the Notice to Proceed.
  2. Substantial Completion: Within 90 days after the date of the Notice to Proceed.
  3. Complete and Ready for Final Payment: Within 150 days after the date of the Notice to Proceed.

F. Drawings:

1. Drawings issued with and forming part of the Contract Documents are listed below:

<i>Drawing No.</i>	<i>Rev. No.</i>	<i>Date of Drawing or Latest Revision</i>	<i>Title</i>
C-01	0	August 2009	Existing Site Conditions
C-02	0	August 2009	Site Works
C-03	0	August 2009	Soil Erosion and Sediment Control Plan
C-04	0	August 2009	Soil Erosion and Sediment Control Details
C-05	0	August 2009	Final Contour Plan
C-06	0	August 2009	Subgrade FOR Proposed Cap Contour Plan
C-07	0	August 2009	Cross-Sections
C-08	0	August 2009	Cap Details I
C-09	0	August 2009	Cap Details II

2. Perform the Works in accordance with the Drawings issued "Approved for Construction" by CRA. Such Drawings will be issued to CONTRACTOR after the Notice of Award and will consist of bid Drawings revised as required by CRA and additional Drawings if required by CRA.
3. Revised "Approved for Construction" Drawings may be issued from time to time by CRA and such Drawings will supersede previous revisions.

- G. CONTRACTOR's Use of the Site: When unfavorable weather, soil, drainage, or other unsuitable construction conditions exist, continue operations which will not be adversely affected by such conditions. Do not construct or cause to be constructed any portion of the Works under conditions which would adversely affect the quality of the Works, unless special means or precautions are taken to perform the Works in a proper and satisfactory manner.

1.3 PRICE AND PAYMENT PROCEDURES

A. Measurement and Payment:

1. Payment for the Works will be made in lump sums and unit prices.
2. Measurement and payment requirements are delineated in the individual Sections and complement the criteria of this Article.

3. CRA will take all measurements and compute quantities accordingly. Notify CRA sufficiently in advance of operations to permit required measurements for payment. Assist by providing necessary equipment, workers, and survey personnel as required. Provide reasonable and necessary opportunities and facilities in making measurements.
4. Measurement for Unit Price Work: As specified in individual Sections. Quantities indicated in the Schedule of Prices are for bidding and Contract purposes only and are approximate. Quantities of materials furnished and/or work performed as verified by CRA determine payment.
5. Measurement for Lump Sum Work: CRA will measure or quantify the amount of work eligible for progress payment purposes. Items will be measured by weight, volume, area, or linear means, or combination as appropriate. Such measurements will serve as a basis for estimating percentage payments for partially completed work.
6. Payment for Each Item Includes: Full compensation for furnishing labor, supervision, material, tools, equipment, plant, transportation, services, submittals, and incidentals for performance and completion of the Works in complete accordance with the Contract Documents; erection, application, installation, completion, or construction of an item of the Works; overhead and profit; and all other miscellaneous items for which separate payment is not provided under other pay items of the Schedule of Prices. All work not specifically set forth as a separate pay item in the Schedule of Prices shall be considered as a subsidiary obligation of CONTRACTOR and all costs in connection therewith shall be included in the amounts and prices stipulated in the Schedule of Prices. CONTRACTOR shall properly and fairly distribute indirect costs to each pay item. Final payment for work governed by unit prices will be made on the basis of the actual measurements and quantities approved by CRA multiplied by the unit price stipulated in the Schedule of Prices. Final payment for work governed by lump sum prices will be made on the basis of the applicable lump sum prices stipulated in the Schedule of Prices.
7. Defect Assessment: Replace the Works or portions of the Works not conforming to specified requirements. If, in the opinion of CRA, it is not practical to remove and replace the defective work, CRA will direct one of the following remedies:
  1. The defective work may remain, but the price will be adjusted to a new price at the discretion of CRA.
  2. The defective work will be partially repaired to the instructions of CRA and the price will be adjusted to a new price at the discretion of CRA.
8. Non-payment for Rejected Products: Payment will not be made for any of the following:
  1. Products wasted or disposed in a manner that is not acceptable.
  2. Products determined as unacceptable before or after placement.
  3. Products not completely unloaded from the transporting vehicle.
  4. Products placed beyond the lines and levels of the required Works.
  5. Products remaining on hand after completion of the Works.

6. Loading, hauling, and disposing of rejected products.

#### 1.4 ADMINISTRATIVE REQUIREMENTS

- A. Specification Language: These Project Specifications are written in imperative mood and are in abbreviated or streamlined form and include incomplete sentences. This imperative language is directed to CONTRACTOR, unless specifically noted otherwise. Omission of words or phrases, such as "the CONTRACTOR shall", "shall be", "a", "the", and "all" are intentional. Omitted words or phrases shall be supplied by inference in the same manner as they are when a "note" occurs on the Drawings.
- B. Mobilization and Startup:
  1. Do not mobilize to the Site without CRA's prior written authorization. Ensure insurance as required by the Contract Documents is in full force.
  2. Perform planning and scheduling activities as necessary for the performance of the Works.
  3. Purchase materials and mobilize equipment, supplies, and incidentals to the Site.
  4. Use existing Site access roads to the designated work areas during mobilization. Complete improvements to roads as necessary for the performance of the Works.
  5. Site temporary construction facilities in areas designated by CRA. Obtain CRA's approval prior to changing locations of temporary construction facilities. Do not use other areas without CRA's prior approval. Provide additional land and access thereto not shown or described that may be required by CONTRACTOR for temporary construction facilities or storage of materials with no liability to OWNER or CRA. Relocate construction equipment or other materials or equipment as required for the performance of the Works.
  6. Do not commence work involving contact with potentially contaminated materials until decontamination facility is operational and approved by CRA.
  7. Furnish submittals as required by these Specifications.
- C. Coordination:
  1. Do not deliver material or equipment of any kind to the Site until approval in writing has been applied for and obtained by CONTRACTOR from CRA.
  2. Coordinate delivery of material and equipment to the Site with work sequence; schedule deliveries to limit requirement for storage at the Site to the practical minimum; limit on-Site storage of materials to areas approved by CRA.
- D. Progress Meetings:
  1. CRA will schedule and administer meetings throughout the progress of the Works at maximum weekly intervals or more frequently as required.
  2. CRA will make arrangements for meetings, prepare agenda with copies for participants, and preside at meetings.

3. Attendance Required: CONTRACTOR and CONTRACTOR's health and safety officer.
4. Agenda:
  1. Review of minutes of previous meetings.
  2. Review of work progress and maintenance of construction progress schedule.
  3. Field observations, problems, and decisions.
  4. Identification of problems that impede planned progress.
  5. Review of submittals schedule and status of submittals.
  6. Review of off-Site material fabrication/processing and delivery schedules.
  7. Review of health and safety concerns and issues including air monitoring results.
  8. Maintenance of quality and work standards.
  9. Effect of proposed changes on progress schedule and coordination.
  10. Other business relating to the Works.
5. CRA will record minutes and distribute copies to participants and those affected by decisions made. Identify errors in the minutes, if any, to CRA in writing within 3 days of receipt.

E. Submittal Procedures:

1. Unless directed otherwise, transmit submittals to CRA.
2. Transmit each submittal with CRA accepted form and the correct number of copies.
3. Sequentially number the transmittal form. Revise submittals with original number and a sequential alphabetic suffix.
4. Identify the Project, CONTRACTOR, Subcontractor, or Supplier; pertinent Drawing and detail number and Section number, as appropriate.
5. Apply CONTRACTOR's approval stamp prior to initial submission to CRA, signed and dated, certifying that CONTRACTOR has satisfied CONTRACTOR's obligations under the Contract Documents including, but not limited to review and approval, verification of products required, field dimensions, adjacent construction work, and coordination of information with respect to CONTRACTOR's review and approval of that submittal. Unstamped or unsigned submittals will be returned by CRA without action.
6. Except as specified otherwise, for each submittal for review allow 3 days excluding delivery time to and from CONTRACTOR. Schedule submittals to expedite the Contract and in accordance with specified scheduling. Coordinate submission of related items.

7. Identify product or system limitations which may be detrimental to successful performance of the completed Works.
8. Provide space for CRA's review stamp and comments on submittals.
9. Make corrections to each submittal required by CRA. Promptly revise and resubmit the required number of corrected copies of each submittal and submit new submittals required by such correction; identify changes made since previous submission and changes other than those requested by CRA.
10. Promptly distribute copies of reviewed submittals to Subcontractors, Suppliers, and other concerned parties as appropriate. Instruct parties to promptly report any inability to comply with provisions.
11. Submittals not requested will not be recognized or processed. Submittals received directly from Subcontractors, Suppliers, Vendors, or other Representatives or without CONTRACTOR stamp will be returned by CRA without action.
12. It is the responsibility of CONTRACTOR to review submittals made by Suppliers and Subcontractors before transmitting them to CRA to assure proper coordination of the Works and to determine that each submittal is in accordance with CONTRACTOR's desires and that there is sufficient information about materials and equipment for CRA to determine compliance with the Drawings and Specifications. Incomplete or inadequate submittals will be returned for revision without review.
13. Unless specified otherwise submit 3 copies of submittals.
14. Requirements of this Article shall apply to all required submittals.

## 1.5 QUALITY REQUIREMENTS

### A. Quality Control:

1. Monitor quality control over suppliers, manufacturers, products, services, Site conditions, and workmanship, to produce Works of specified quality.
2. Comply with manufacturers' instructions, including each step in sequence.
3. Should manufacturers' instructions conflict with the Contract Documents, request clarification from CRA before proceeding.
4. Comply with specified standards as minimum quality for the Works except where more stringent tolerances, codes, or specified requirements indicate higher standards or more precise workmanship.
5. Perform work by persons qualified to produce workmanship of specified quality. Use persons licensed to perform the Works where required by these Specifications or Laws and Regulations.
6. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, physical distortion, or disfigurement.

7. Materials furnished and finished or intermediate stages of the Works shall be sampled, tested, and inspected as specified in the individual Sections and as required by reference standards.
8. Performance of tests or observations by CRA are for the sole benefit of CRA and are not intended to replace CONTRACTOR's quality control program. CONTRACTOR is solely responsible for establishing and implementing a quality control program to ensure that the Works are in accordance with the Contract Documents.
9. It is CONTRACTOR's responsibility to notify CRA when CONTRACTOR believes the Works (or intermediate stages or parts of the Works) are of specified quality and to permit CRA to perform independent tests or analyses.
10. Testing by CRA or failure to detect defective work shall not prevent rejection when defect is discovered, nor shall it obligate OWNER for final acceptance.

B. References:

1. For products or workmanship specified by association, trade, or other consensus standards, comply with requirements of the standard, except when more rigid requirements are specified or are required by Laws and Regulations.
2. Conform to reference standard by date of issue current as of bid closing date, except where a specific date is established by Laws and Regulations or by individual Section.
3. Specific provisions of Laws or Regulations may be referenced in the Project Specifications to assist CONTRACTOR and identify options selected by CRA. Such references do not relieve CONTRACTOR from compliance with other applicable provisions of Laws and Regulations not specifically referenced.
4. No inference or provision of any reference document including but not limited to any standard specification, manual, or code shall be effective to change the relationships, duties, and responsibilities of CONTRACTOR or CRA from those set forth in the Contract Documents, nor shall it be effective to assign to CRA any duty or authority to supervise or direct the furnishing or performance of the Works or any duty or authority to undertake responsibility inconsistent with the provisions of the Contract.
5. Publications referred to in these Specifications form part of the Specifications to the extent specified in individual Sections.
6. In case of conflict or discrepancy between a reference standard and the Project Specifications or with another reference standard, the more stringent requirements shall apply.
7. Should specified reference standards conflict with the Contract Documents, request clarification from CRA before proceeding.

C. Inspecting and Testing by CRA:

1. CRA may employ and pay for services of an independent inspecting company and testing laboratory to perform inspecting and testing services as specified in individual Sections.

2. Employment of inspecting company and testing laboratory and services performed by such inspecting company and testing laboratory in no way relieves CONTRACTOR of obligation to perform the Works in accordance with requirements of the Contract Documents.
3. Reports will be submitted by the independent firm to CRA, indicating observations and results of tests and indicating compliance or non-compliance with the Contract Documents. Copies will be provided to CONTRACTOR upon request.
4. Deliver to inspecting company and testing laboratory at designated location, adequate samples of materials proposed to be used that require testing.
5. Cooperate with personnel of inspecting company and testing laboratory and provide safe access to the Works and the manufacturer's operations.
6. Provide incidental labor and facilities:
  1. To provide access to the Works to be tested.
  2. To obtain and handle samples at the Site or at source of products to be tested.
  3. To facilitate tests and inspections.
  4. For inspecting company and testing laboratory's exclusive use for storage and curing of test samples.
7. Notify CRA and inspecting company and testing laboratory 24 hours prior to expected time for operations requiring inspecting and testing services.
8. Retesting required because of CONTRACTOR's negligence non-conformance to specified requirements will be performed by the same inspecting company and testing laboratory on instructions by CRA. Costs for retesting and reinspection will be payable by CONTRACTOR to CRA on demand or CRA may deduct cost of inspecting or testing charges from monies which are due or may become due CONTRACTOR.
9. If defects or deficiencies are revealed during testing or inspecting, correct such defects and deficiencies and retest affected portions of the Works.

#### 1.6 TEMPORARY UTILITIES

- A. Electricity: Provide, maintain, and pay for temporary power service necessary for performance of the Works.
- B. Water Service:
  1. Existing potable water source will be available at the OWNER's groundwater treatment building.
  2. OWNER will pay cost of water used. Exercise measures to conserve water.
  3. Do not use wastewater storage tanks to store or haul potable water.

4. Potable water tanks shall be clean and contaminant free, inside and outside.

## 1.7 TEMPORARY FACILITIES

### A. Equipment Decontamination Facility:

1. Prior to commencing work involving equipment contact with potentially contaminated materials, construct an equipment decontamination pad to accommodate the largest piece of potentially contaminated equipment.
2. Provide, operate, and maintain suitable portable, high-pressure, low-volume decontamination wash unit(s) equipped with self-contained water storage tank and pressurizing system and capable of heating and maintaining wash waters to 180 degrees F and providing a nozzle pressure of 150 psi.
3. Provide, operate, and maintain necessary equipment, pumps, and piping required to collect and contain equipment decontamination wastewater and sediment and transfer same to approved storage facilities.

### B. Emergency and First-aid Equipment: Comply with Section 01351 - Health and Safety.

### C. Sanitary Facilities:

1. Provide and maintain required temporary sanitary facilities and enclosures in accordance with OSHA.
2. Remove and dispose of sanitary wastes off the Site on a periodic basis as required and in accordance with Laws and Regulations.

### D. Wastewater Storage Tanks:

1. Provide, operate, and maintain wastewater storage tanks to store water collected from dewatering operations and Equipment Decontamination Facility.
2. Discharges: Do not discharge any wastewaters to on-Site sewer systems. Obtain CRA's approval prior to discharge of wastewater.
3. Provide pumps and piping to convey collected wastewaters to designated wastewater storage tanks; provide wastewater storage tanks with a minimum total live capacity of 5,000 gallons.
4. Install wastewater storage tanks in locations directed by CRA.
5. Support tank(s) on a temporary aboveground foundation provided by CONTRACTOR.
6. Connect pumps, piping, valves, miscellaneous items, and necessary utilities as required for operation of the facilities. Protect tanks, valves, pumps, piping, and miscellaneous items from freezing.
7. Do not operate wastewater storage facility until inspected by CRA.

8. Transport and dispose of wastewaters at the OWNER's groundwater treatment system.

#### 1.8 VEHICULAR ACCESS

- A. Construct and maintain temporary all-weather access roads from public thoroughfares and Site roadways to construction area at a width and load bearing capacity to provide unimpeded access for construction purposes as CONTRACTOR requires for performance of the Works.
- B. Construct and maintain temporary bridges and culverts to span low areas and allow unimpeded drainage.
- C. Extend and relocate temporary roads as work progress requires. Provide detours as necessary for unimpeded traffic flow.
- D. Provide unimpeded access for emergency vehicles. Maintain sufficient width and turning space.
- E. Provide and maintain access to fire hydrants and control valves, free of obstructions.
- F. Remove mud from vehicle wheels before entering public roads.
- G. Obtain CRA's prior approval for location and extent of temporary roads.
- H. Provide signs, barricades, gatepersons, flagpersons, flares and lights, and other measures required; provide flagpersons for construction traffic crossing or entering local traffic routes or otherwise required on the Site.
- I. CRA may collect soil samples for chemical analyses from the traveling surfaces of constructed and existing access routes prior to, during, and upon completion of the Works. Excavate and dispose of clean soil contaminated by CONTRACTOR's activities at no additional cost to OWNER.
- J. Prevent contamination of access roads. Immediately scrape up debris or material on access roads that is suspected to be contaminated as determined by CRA; transport and dispose of in appropriate off-Site disposal facility. Clean access roads at least once per shift.

#### 1.9 TEMPORARY BARRIERS AND ENCLOSURES

- A. Fencing:
  1. Construction: Standard snow fence.
  2. Provide fence to delineate work areas.
  3. Enforce and require that workers and visitors observe and respect the limits marked with temporary fencing.

B. Security:

1. Provide security and facilities to protect the CONTRACTOR'S equipment and the Site from unauthorized entry, vandalism, or theft. Control access to the Site at all times.
2. Initiate security program at time of mobilization to the Site.
3. Maintain security program throughout construction period until demobilization from the Site.
4. All workers and visitors shall log in and out at existing OWNER security office for access to the Site through OWNER's property.
5. Do not allow cameras on the Site or photographs taken except by prior written approval of OWNER.
6. If unauthorized personnel are observed on the Site, notify CRA.

1.10 TEMPORARY CONTROLS

A. Water Control:

1. Maintain excavations free of water. Provide, operate, and maintain pumping equipment.
2. Protect the Site from puddling or running water. Grade the Site to drain. Provide water barriers as necessary to protect the Site from soil erosion.
3. Prevent surface water runoff from leaving work areas.
4. Contain and collect wastewaters and transfer such collected wastewaters to wastewater storage tanks.
5. Do not discharge decontamination water, or surface water runoff, or groundwater that may have come in contact with potentially contaminated material, off the Site or to municipal sewers.
6. Provide, operate, and maintain necessary equipment appropriately sized to keep excavations, staging pads, and other work areas free from water.
7. Have on hand sufficient pumping equipment, machinery, and tankage in good working condition for ordinary emergencies, including power outage, and competent workers for operation of the pumping equipment.
8. Direct surface waters that have not contacted potentially contaminated materials to existing surface drainage systems.
9. Control surface drainage including ensuring that gutters are kept open at all times, water is not directed across or over pavements or sidewalks except through approved pipes or properly constructed troughs, and runoff from unstabilized areas is intercepted and diverted to a suitable outlet.

10. Dispose of water in a manner not injurious to public health or safety, to property, or to any part of the Works completed or under construction.
11. Contain and collect surface water runoff from potentially contaminated materials.

B. Dewatering:

1. Dewater the various parts of the Works including, without limitation, open excavations and work areas.
2. Employ construction methods, plant, procedures, and precautions that will ensure the Works, including excavations, are stable, free from disturbance, and dry.
3. Dewatering Methods: Includes surface or free water control systems employing ditches, diversions, drains, pipes, and/or pumps; and any other measures necessary to enable the whole of the Works to be carried out in the dry.
4. Provide sufficient and appropriate labor, plant, and equipment necessary to keep the Works free of water including standby equipment necessary to ensure continuous operation of dewatering system.
5. Take precautions necessary to prevent uplift of any structure or pipeline and protect excavations from flooding and damage due to surface runoff.

C. Dust and Particulate Control:

1. Execute the Works by methods to minimize raising dust from construction operations.
2. Implement and maintain dust and particulate control measures immediately during construction and in accordance with the State of Kentucky regulations.
3. Provide positive means to prevent airborne dust from dispersing into atmosphere. Use potable water for a water misting system for dust and particulate control.
4. Do not use chemical means for a water misting system for dust and particulate control without CRA's prior written approval.
5. As a minimum, use appropriate covers on trucks hauling fine or dusty material and use watertight vehicles to haul wet materials.
6. Prevent dust from becoming a nuisance to adjacent property owners or occupants.
7. CRA may stop work at any time when CONTRACTOR's control of dusts and particulates is inadequate for the wind conditions present at the Site, or when the air quality monitoring indicates that the release of fugitive dusts and particulates into the atmosphere equals or exceeds the specified levels.
8. In the event that CONTRACTOR's dust and particulate control is not sufficient for controlling dusts and particulates into the atmosphere, work shall be discontinued and a meeting held between CRA and CONTRACTOR to discuss the procedures that CONTRACTOR proposes to resolve the problem. Make all necessary changes to operations

prior to resuming any excavation, handling, processing, or any other work that may cause a release of dusts or particulates.

D. Pollution Control:

1. Provide methods, means, and facilities to prevent contamination of soil, water, and atmosphere from discharge of noxious toxic substances and pollutants produced by construction operations.
2. Be prepared to intercept, clean up, and dispose of spills or releases that may occur, whether on land or water. Maintain materials and equipment required for cleanup of spills or releases readily accessible on the Site.
3. Take immediate action using available resources to contain and mitigate the effects on the environment and persons from any spill or release.

1.11 PRODUCT REQUIREMENTS

A. Product Substitutions:

1. Document each request for substitutions with complete data substantiating compliance of proposed substitution with the Contract Documents.
2. A request for substitution constitutes a representation that CONTRACTOR:
  1. Has investigated proposed product and determined that it meets or exceeds the quality level of the specified product.
  2. Will provide the same warranty for the substitution as for the specified product.
  3. Will coordinate installation and make changes to other work which may be required for the Works to be complete at CONTRACTOR's expense and at no additional cost to CRA and OWNER.
  4. Waives claims for additional costs or time extension which may subsequently become apparent.
3. Substitutions will not be considered when they are indicated or implied on Shop Drawings or product data submittals without separate written request.
4. Substitution Submittal Procedure:
  1. Submit 3 copies of request for substitution for consideration. Limit each request to 1 proposed substitution.
  2. Submit Shop Drawings, product data, and certified test results and other data as required by CRA attesting to the proposed product equivalence. Burden of proof is on CONTRACTOR.
  3. CRA will notify CONTRACTOR in writing of decision to accept or reject request.

4. CRA will be sole judge as to the acceptance or rejection of CONTRACTOR's request.
5. In the event CONTRACTOR obtains CRA's approval for the use of product other than that which is shown or specified, CONTRACTOR shall, at CONTRACTOR's own expense and using methods approved by CRA, make all changes to the Works, including structures, piping, electrical, equipment, and controls, that may be necessary to accommodate this product.

B. Product Delivery and Handling Requirements:

1. Make all arrangements for transportation, delivery, and handling of products required for prosecution and completion of the Works.
2. Shipments of products to CONTRACTOR or subcontractors shall be delivered to the Site only during regular working hours. Shipments shall be addressed and consigned to the proper party giving name of Project, street number, and city. Do not deliver shipments to OWNER except where otherwise directed in writing.
3. Provide advance notice of delivery of products to the Site as required in other Sections. Do not deliver products of any kind to the Site until approval in writing has been applied for and obtained by CONTRACTOR from CRA.
4. Arrange delivery of products to the Site in accordance with work sequence and in ample time to facilitate inspection prior to installation. Schedule deliveries to limit requirement for storage at the Site to the practical minimum.
5. Coordinate deliveries to avoid conflict with the Works and conditions at the Site and to accommodate the following:
  1. Work of Other Contractors, or OWNER.
  2. Limitations of storage space.
  3. Availability of equipment and personnel for handling products.
  4. OWNER's use of the Site.
6. Do not have products delivered to the Site until related Shop Drawings or Samples have been approved by CRA.
7. Do not have products delivered to the Site until required storage facilities have been provided.
8. Transport and handle products in accordance with manufacturers' instructions.
9. Immediately on delivery, inspect shipments to ensure that products comply with requirements of the Contract Documents and reviewed submittals, quantities are correct, and products are undamaged.
10. Provide equipment and personnel to handle products by methods to prevent soiling, disfigurement, or damage.

C. Product Storage and Handling Requirements:

1. Limit on-Site storage of products to areas shown on the Drawings or otherwise approved by CRA.
2. Make arrangements and provisions necessary for storage of materials and equipment.
3. Place removed materials, construction equipment, and materials and equipment to be incorporated into the Works so as not to injure any part of the Works or existing facilities and so that free access can be had at all times to all parts of the Works.
4. Store and protect products in accordance with manufacturers' recommendations and instructions and requirements of Specifications, with seals and labels intact and legible.
5. Store sensitive products in weathertight, climate-controlled enclosures. Protect products subject to ultraviolet degradation from direct exposure to sunlight.
6. For exterior storage of fabricated products, place on sloped supports, above ground.
7. Provide off-Site storage and protection when the Site does not permit on-Site storage or protection.
8. Cover products subject to deterioration with impervious sheet covering. Provide ventilation to avoid condensation or potential degradation of product.
9. Store loose granular materials on solid flat surfaces in a well-drained area. Prevent mixing with foreign matter.
10. Furnish equipment and personnel to store products by methods to prevent soiling, disfigurement, or damage.
11. Arrange storage of products to permit easy access for inspection. Periodically inspect to verify products are undamaged and are maintained in acceptable condition.
12. Store materials and equipment neatly and compactly, and in locations that will cause a minimum of inconvenience to Other Contractors, public travel, adjoining owners, tenants, and occupants.
13. Protect delivered products from contamination or damage.
14. Do not use lawns, grass plots, or other private property for storage purposes without written permission of CRA or other person in possession or control of such premises.
15. CONTRACTOR shall be fully responsible for loss or damage to stored products, materials, and equipment.

## 1.12 EXECUTION REQUIREMENTS

### A. Examination:

1. Prior to commencement of work at the Site, inspect the Site with CRA to review and establish the condition of surface features including existing roads, parking areas, buildings, wells, trees and other plants, grassed areas, fencing, service poles, wires, paving, and survey bench marks or monuments on or adjacent to the Site which may be affected by the Works. This inventory shall be mutually agreed between CRA and CONTRACTOR and shall not thereafter be subject to dispute. Such inventory, as may be amended from time to time, will be used by CRA to check compliance by CONTRACTOR with the requirements of the Contract Documents.
2. Verify location and depth of underground piping in Areas 1, 2, 3, and 5 associated with remedial systems to include vapor extraction piping, groundwater forcemain, permitted outfall, and electrical.
3. Provide ongoing review, inspection, and attendance during performance of the Works to properly document conditions. Promptly inform CRA of any existing condition at the Site affected by the Works that may require restoration, repair, or replacement. Do not cover up any of the Works without prior approval from CRA.
4. Maintain and protect existing Site structures and facilities from damage which may be affected by the Works while work is in progress. Repair or replace damage resulting from the Works to CRA's approval.
5. Verify that existing Site conditions and substrate surfaces are acceptable for subsequent work. Beginning new work means acceptance by CONTRACTOR of existing conditions.
6. Examine and verify specific conditions described in individual Sections.

### B. Restoration:

1. As a minimum, restoration shall mean replacement, repairs, or reconstruction to a condition at least as good as or better than the condition prior to commencement of the Works.
2. Except where specifically required otherwise by other Sections, restore areas of the Works and areas affected by the performance of the Works to conditions that existed prior to commencement of the Works and to match condition of similar adjacent, undisturbed areas.
3. Ensure that restored areas match existing grade and surface drainage characteristics, except as otherwise specified, and ensure a smooth transition from restored surfaces to existing surfaces.
4. Do not alter original conditions without prior written approval from CRA.
5. Without limiting the generality of the foregoing or other requirements of the Contract Documents, preserve and protect existing features encountered at the Site during the performance of the Works including but not limited to buildings, wells, structures, curbs and gutters, fences, pavement, manholes and catch basins, utilities, roads, streets, walks, grassed areas, and other graded or improved areas.

6. Prior to commencement of restoration work, inform CRA of proposed material, methods, and procedures to repair, replace, or reconstruct any disturbed, damaged, or suspected damage to the Works.

C. Field Surveying:

1. Unless otherwise specified, CRA will establish reference bench marks and base lines adjacent to the Works. CONTRACTOR shall be responsible for laying out the Works from established reference points.
2. Verify locations of survey control points prior to starting work. Promptly notify CRA of any discrepancies discovered.
3. Notify CRA in writing at least 5 working days in advance of commencing work on any part of the construction to enable CRA to establish bench marks and base lines.
4. Locate, preserve, and protect survey control and reference points as set or established by CRA. Promptly report to CRA the loss or destruction of any reference point or relocation required because of changes in grades or other reasons. Make good any errors entering into the Works through CONTRACTOR failure to notify CRA concerning lack of preservation of such survey reference points. Accurately replace or relocate dislocated reference or survey control points based on original survey control by professionally qualified personnel. Make no changes without prior written notice to and approval of CRA.
5. Develop and make such additional detailed surveys as are needed for construction, such as bench marks, slope stakes, batterboards, stakes for establishing the design elevations of excavations and final grades, and other working points, lines, and elevations. Maintain bench marks and base lines established by CRA, existing property boundaries, lines and grade hubs, and other references and construction or survey points.
6. CRA may, at any time, check CONTRACTOR's survey and layout work but this shall not relieve CONTRACTOR of any of his responsibilities to carry out the Works to the lines and grades as set out in accordance with the Drawings and the Project Specifications or as otherwise necessary for performance of the Works in accordance with the Contract Documents.
7. Provide reasonable and necessary opportunities and facilities for setting points and making measurements during construction.
8. Maintain a complete and accurate log of control and survey work as it progresses.
9. Establish elevations, lines, and levels, utilizing recognized engineering survey practices.
10. Submit paper and digital copies of registered Site drawing and certificate signed by the land surveyor engaged by CONTRACTOR that the elevations and locations of the work are in conformance with the Contract Documents. Provide digital copy on Compact Disc (CD) compatible for use with Windows 2000/XP and AutoCad 2000/2002.

D. Equipment Decontamination:

1. Construct equipment decontamination pad(s) as shown on the Drawings.
2. Do not commence work involving equipment contact with potentially contaminated material until the Equipment Decontamination Facility is operational.
3. Decontaminate equipment after working in potentially contaminated work areas and prior to subsequent work or travel on clean areas.
4. Perform equipment decontamination on CONTRACTOR-constructed equipment decontamination pad(s).
5. At a minimum, perform the following steps during equipment decontamination:
  1. Mechanically remove packed dirt, grit, and debris by scraping and brushing, without the use of steam or high-pressure water, to reduce the amount of water needed and the amount of contaminated rinsate generated.
  2. Use high-pressure, low-volume, hot water or steam supplemented by detergents or solvents, as appropriate and as approved by CRA.
  3. Pay particular attention to tire treads, equipment tracks, springs, joints, sprockets, and undercarriages.
  4. Scrub surfaces with long handle scrub brushes and a cleaning agent.
  5. Rinse off and collect cleaning agent.
  6. Air dry equipment in the Clean Zone before removing from the Site or travel on clean areas.
  7. Perform an assessment as directed by CRA to determine the effectiveness of decontamination.
6. Maintain an inspection record on the Site that includes:
  1. Equipment descriptions with identification numbers or license plates.
  2. Time and date entering the Equipment Decontamination Facility.
  3. Time and date exiting the Equipment Decontamination Facility.
  4. Name of inspector with comment stating that decontamination was performed and completed.
7. Each piece of equipment will be inspected by CRA after decontamination and prior to removal from the Site and/or travel on clean areas. CRA will have right to require additional decontamination to be completed if deemed necessary.
8. Take appropriate measures necessary to minimize the drift of mist and spray during decontamination, including provision of wind screens.

9. Collect and decontaminate wastewaters and sediments that accumulate on the equipment decontamination pad. Transfer wastewaters to designated wastewater storage tank.
  10. Transfer sediments to disposal transport vehicle.
  11. Furnish and equip personnel engaged in equipment decontamination with protective equipment including suitable disposable clothing, respiratory protection, and face shields.
  12. Have on hand sufficient pumping equipment of adequate pumping capacity and associated machinery and piping in good working condition for ordinary emergencies, including power outage, and competent workers for operation of pumping equipment. Maintain piping and connections in good condition and leak-free.
- E. Final Decontamination and Removal:
1. Perform final decontamination of construction facilities, equipment, and materials that may have come in contact with potentially contaminated materials prior to removal from the Site.
  2. Perform decontamination as specified in this Section to the satisfaction of CRA. CRA will have right to direct CONTRACTOR to perform additional decontamination if required.
  3. Remove surplus materials and temporary facilities and controls from the Site.
- F. Final Waste Removal and Disposal:
1. Dispose of non-contaminated waste materials, litter, debris, and rubbish off the Site.
  2. Dispose of contaminated personnel decontamination equipment and materials that cannot be decontaminated at licensed and permitted waste disposal facility in accordance with Laws and Regulations. Obtain from OWNER approval of facilities acceptable for off-Site disposal of wastes. Transport waste materials from the Site in accordance with Laws and Regulations.
  3. Wastewater: Transfer collected wastewater to existing OWNER groundwater treatment system and discharge at location defined by CRA. Following completion of tank emptying, decontaminate the tank interior with a steam or high-pressure water wash supplemented by detergent (Alconox). Dispose of tank decontamination water with tank contents.
- G. Closeout Procedures: Complete and furnish submittals that are required by governing or other authorities or by the Contract Documents. Final payment shall not become due and payable until submittals have been made acceptable to CRA.
- H. Record Documents:
1. Maintain 1 set of the following record documents on the Site; record actual revisions to the Works:
    1. Drawings.
    2. Specifications.

3. Change Orders and other modifications to the Contract.
  4. Reviewed Shop Drawings, product data, and samples.
  5. Manufacturer's instruction for assembly, installation, and adjusting.
2. Ensure entries are complete and accurate, enabling future reference by OWNER.
  3. Store the record documents separate from documents used for construction.
  4. Record information concurrent with construction progress.
  5. Specifications: Legibly mark and record, at each Section of the Specifications, a description of actual products installed, including the following:
    1. Manufacturer's name and product model and number.
    2. Product substitutions or alternates utilized.
    3. Changes made by modifications.
  6. Record Documents and Shop Drawings: Legibly mark each item to record actual construction including:
    1. Field changes of dimension and detail.
    2. Details not on original Drawings.
    3. Provide AutoCad files of as-built drawings on CD.
    4. Provide survey drawing and certificate.
  7. Remove CRA title block and seal from all documents generated by CONTRACTOR.
  8. Submit record documents to CRA with final invoice.
  9. Site Records: Keep a complete, current, and permanent record at the Site of all data required to be maintained by the Contract Documents, including, but not limited to, the dates of commencement and completion of all aspects of the Works, daily records of the number of workers, the number and type of equipment engaged on the Works and on each division of the Works, and test results, and make such data available to CRA upon request.

I. Warranties:

1. Obtain warranties, executed in duplicate by responsible Subcontractors, Suppliers, and manufacturers, within 14 days after completion of the applicable item of work.
2. Verify that documents are in proper form, contain full information, and are notarized.
3. Co-execute submittals when required.

4. Retain warranties until time specified for submittal.
5. Bind in commercial quality 8 1/2 by 11-inch 3-D side ring binders with durable plastic covers. Identify each binder with typed title WARRANTIES, with title of Project; name, address, and telephone number of CONTRACTOR and equipment Supplier; and name of responsible company principal. Neatly type Table of Contents, in the sequence of the Table of Contents of the Project Specifications, with each item identified with the number and title of the Section in which specified, and the name of the project or work item. Separate each warranty with index tab sheets keyed to the Table of Contents listing. Provide full information, using separate typed sheets as necessary. List Subcontractor, Supplier, and manufacturer, with name, address, and telephone number of responsible principal.
6. Submit prior to final inspection.

END OF SECTION

SECTION 01351  
HEALTH AND SAFETY

1.1 SECTION INCLUDES

- A. References.
- B. General requirements.
- C. Basis of program.
- D. Site characterization.
- E. Submittals.
- F. Health and Safety Officer.
- G. Personnel health, safety, and hygiene.
- H. Air monitoring.
- I. Contingency and Emergency Response Plans.
- J. Site control.

1.2 REFERENCES

- A. Section 01000 - General Requirements: Requirements for references.
- B. United States Federal Government - Code of Federal Regulations (CFR):
  - 1. 29 CFR 1910.120 - Subpart H Hazardous Materials - Hazardous Waste Operations and Emergency Response.
  - 2. 29 CFR 1910.134 - Subpart I - Personal Protective Equipment- Respiratory Protection.
  - 3. 29 CFR 1910.146 - Subpart J - General Environmental Controls - Permit-required Confined Spaces.
  - 4. 29 CFR 1910.1200 - Subpart Z - Toxic and Hazardous Substances - Hazard Communication.
  - 5. 29 CFR 1926.65 - Subpart D - Occupational Health and Environmental Controls - Hazardous Waste Operations and Emergency Response.
  - 6. 29 CFR 1910 Subpart I - Personal Protective Equipment.
  - 7. 29 CFR 1910 Subpart Z - Toxic and Hazardous Substances.

8. 29 CFR 1926 Subpart P - Excavations.

1.3 GENERAL REQUIREMENTS

- A. Develop a written Site-specific Health and Safety Plan which complies with 29 CFR 1910.120 and 29 CFR 1926.65, prior to commencing any on-Site work and continue to implement, maintain, and enforce the plan until final demobilization from the Site. The development, implementation, and maintenance of the Site-specific Health and Safety Plan is CONTRACTOR's sole responsibility. CONTRACTOR's Site-specific Health and Safety Plan, as a minimum, shall address the specifications contained herein.
- B. The health and safety guidelines contained herein are intended to provide for a safe and minimal risk working environment for on-Site personnel and to minimize the impact of activities involving contact with any hazardous materials or hazardous wastes on the general public and the surrounding environment.
- C. Should CONTRACTOR seek relief from or substitution for any portion or provision of the minimum health and safety guidelines specified herein or CONTRACTOR's Site-specific Health and Safety Plan, such relief or substitution shall be requested of CRA in writing, and if accepted by CRA, will be authorized in writing.
- D. Responsibility: Be responsible for the safety of persons and property on the Site and for the protection of persons off the Site and the environment to the extent that they may be affected by the conduct of the Works. Comply with and enforce compliance by employees of CONTRACTOR and Representatives with safety requirements of the Contract Documents, Laws and Regulations, Inc. health and safety rules and training, and CONTRACTOR's Site-specific Health and Safety Plan. CONTRACTOR acknowledges that safety and environment protection obligations are of paramount importance regarding all of the work to be performed under the Contract Documents.
- E. Hazard Communication Requirements:
  - 1. Comply with the requirements of Occupational Safety and Health Administration (OSHA) "Hazard Communication" rule, 29 CFR 1910.1200. Obtaining information on any hazardous chemical or harmful physical agent to which personnel of CONTRACTOR and Representatives, and visitors have potential exposure while on the Site.
  - 2. CONTRACTOR shall provide CRA with Material Safety Data Sheet (MSDS) documentation on any "hazardous" chemicals that CONTRACTOR or Representatives plan to bring onto the Site. In addition, CONTRACTOR shall be responsible for meeting container warning label requirements of OSHA rule.
- F. Work Stoppage: Give precedence to the safety and health of the public and on-Site personnel and the protection of the environment over cost and schedule considerations for all Project work. The Health and Safety Officer shall be responsible for decisions regarding when work will be stopped or started for health or safety considerations and shall have the authority, in the Health and Safety Officer's discretion, to stop or start the work for health or safety considerations. CRA will have the right to stop work for health and safety considerations.

- G. Unforeseen Hazards: Should any unforeseen or Site-peculiar safety-related factor, hazard, or condition become evident during performance of the Works at the Site, bring such to the attention of CRA verbally and in writing as quickly as possible, for resolution. In the interim, take prudent action to establish and maintain safe working conditions and to safeguard employees of CONTRACTOR and Representatives, the public, CRA, and the environment.

#### 1.4 BASIS OF PROGRAM

- A. OSHA standards and regulations contained in 29 CFR 1910 and 1926 provide the basis for the health and safety program. The program also reflects the position of United States Environmental Protection Agency (USEPA) and National Institute for Occupational Safety and Health (NIOSH) regarding procedures recommended or required to ensure safe operations at sites containing hazardous or toxic materials.

#### 1.5 SITE CHARACTERIZATION

- A. Work at the Site will involve contact with soils, sediments and groundwater, which may contain any or all of the following chemical substances:
1. Acetophenone.
  2. Aroclor 1248 and 1254.
  3. Benzo(a)anthracene.
  4. Benzo(a)pyrene.
  5. Benzo(b)fluoranthene.
  6. Benzo(g,h,i)perylene.
  7. Benzo(k)fluoranthene.
  8. bis(2-Ethyhexyl)phthalate.
  9. Chrysene.
  10. Fluoranthene.
  11. Hexachlorobenzene.
  12. Indeno(1,2,3-CD)pyrene.
  13. Naphthalene.
  14. Phenanthrene.
  15. Pyrene.

16. Biphenyl.
17. Benzaldehyde.

1.6 SUBMITTALS

A. Section 01000 - General Requirements: Requirements for progress submittals.

B. CONTRACTOR's Site-Specific Health and Safety Plan:

1. Within 7 days after the date of the Notice to Proceed and prior to mobilization to the Site, submit a Site-specific Health and Safety Plan which complies with 29 CFR 1910.120, 29 CFR 1926.65, and the Site Health and Safety Plan. As a minimum, the Site-specific Health and Safety Plan shall include the following:
  1. A safety and health risk or hazard analysis for each Site task and operation.
  2. Personnel training assignments in accordance with 29 CFR 1910.120 (e) and 29 CFR 1926.65 (e).
  3. Personal protective equipment to be used by personnel for each Site task and operation being conducted in accordance with 29 CFR 1910.120 (g)(5) and 29 CFR 1926.65 (g) (5).
  4. Medical surveillance requirements in accordance with 29 CFR 1910.120 (f) and 29 CFR 1926.65 (f).
  5. Frequency and types of air monitoring, personnel monitoring, and environmental sampling techniques and instrumentation to be used, including methods of maintenance and calibration of monitoring and sampling equipment to be used.
  6. Site control measures in accordance with 29 CFR 1910.120 (d) and 29 CFR 1926.65 (d).
  7. Decontamination procedures in accordance with 29 CFR 1910.120 (k) and 29 CFR 1926.65 (k).
  8. An emergency response plan meeting the requirements of 29 CFR 1910.120 (l) and 29 CFR 1926.65 (l) for safe and effective responses to emergencies, including necessary personal protective equipment and other equipment.
  9. A written respiratory protection program for Project activities.
  10. Procedures dealing with heat and/or cold stress.
  11. A detailed description of the planned movement of labor, equipment, and materials from and between work areas as work progresses, including measures to be employed to prevent recontamination of previously cleaned areas.
  12. Dust Suppression Program.

13. A detailed description of the personnel decontamination facilities to be employed including the planned phasing of decontamination facilities between work areas as work progresses and the methods to be used to collect, store, treat, and ultimately dispose of personnel decontamination waters and wastes.
  14. A detailed description of the washdown area for decontamination of vehicles and equipment and the methods to be used to collect, store, treat, and dispose of washdown decontamination waters and sediments.
2. CRA will review CONTRACTOR's Site-specific Health and Safety Plan and provide comments to CONTRACTOR within 3 days after receipt of the plan. Revise the plan as appropriate and resubmit the plan to CRA within 3 days after receipt of comments from CRA.
- C. Proof of OSHA Training: Within 7 days after the date of the Notice to Proceed and prior to mobilization to the Site, submit a list of all personnel that will be employed at the Site. For each of the listed personnel, provide proof of training as required under OSHA 29 CFR 1910.120 and 29 CFR 1926.65. Submit proof of training for any additional personnel, as they are sent to the Site.
- D. Medical Surveillance:
1. Within 7 days after the date of the Notice to Proceed and prior to mobilization to the Site, submit certification of medical surveillance for all Site personnel.
  2. Submit additional certification of medical surveillance as personnel are sent to the Site.
- E. Respirator Fit Test: Within 7 days after the date of the Notice to Proceed and prior to mobilization to the Site, submit proof of respirator fit testing for on-Site personnel.
- F. Air Monitoring Reporting: Submit daily on a separate CONTRACTOR designated form air monitoring results.
- 1.7 HEALTH AND SAFETY OFFICER (HSO)
- A. Employ and assign to the Works a competent and authorized representative herein referred to as "Health and Safety Officer". Health and Safety Officer Qualifications:
1. Have a minimum of 2 years Site-related working experience specific to the activities associated with excavation of contaminated materials.
  2. Have a basic working knowledge of state and federal occupational safety and health regulations.
  3. Have formal education and/or training in occupational safety and health.
- B. Health and Safety Officer Responsibilities:
1. Obligated to stop or start the work when it is necessary or advisable for reasons of health or safety.

2. Completing Health and Safety Training Sessions and ensuring that personnel not successfully completing the required training are not permitted to enter the Site to perform work in the Exclusion Zone (EZ) or the Contaminant Reduction Zone (CRZ).
3. Implementing and daily enforcing and monitoring the Site-specific Health and Safety Plan.
4. Be on the Site during the execution of work at the Site.

#### 1.8 PERSONNEL HEALTH, SAFETY, AND HYGIENE

- A. Medical Surveillance: Conduct medical surveillance of personnel as required by 29 CFR 1910.120, 29 CFR 1926.65, and 29 CFR 1910.134.
- B. Training: Furnish personnel assigned to or entering the Site who have successfully completed training required by the applicable OSHA Standards in 29 CFR 1910 and 29 CFR 1926 and specifically with 29 CFR 1910.120 and 1926.65.
- C. Levels of Protection: Establish actual levels of protection for each work area based on planned activity and location of activity. The anticipated levels of personal protection based on work activity are as follows:

<i>Work Activity</i>	<i>Anticipated Level of Personal Protection</i>
1. Contaminated soil/slag and riprap excavation/removal and consolidation in designated cap areas	Modified Level C or Level C
2. Equipment decontamination	Modified Level C or Level C
3. Support zone activities	Level D
4. Backfilling, seeding, fence removal and reinstallation, construction of access road, culvert, and swale	Level D
5. Cap construction	Level D

#### D. Personal Protective Equipment (PPE):

1. Furnish on-Site CONTRACTOR personnel with appropriate PPE. Clean and maintain safety equipment and protective clothing. As a minimum, each worker on Site shall wear a hard hat, safety glasses with side shields, safety boots with steel toes and shank, full-length pants, and long sleeve shirt.
2. Develop protective equipment usage procedures and enforce strict compliance with such procedures by on-Site personnel; include the following procedures as a minimum:
  1. Do not permit prescription eyeglasses to be worn that are not safety glasses. Do not permit contact lenses on the Site within the Exclusion Zone or the Contaminant Reduction Zone.

2. Change respirator cartridges/filters daily during periods of respirator usage or prior to breakthrough, whichever occurs first.
3. Do not permit footwear to be worn that is not steel-toed safety shoes or boots. Cover footwear by rubber overshoes when entering or working in the Exclusion Zone or the Contaminant Reduction Zone.
4. Dispose of or decontaminate PPE worn on the Site at the end of the work day.
5. Decontaminate reusable PPE before reissuing.
6. Do not permit on-Site personnel who have not passed a respirator fit test to enter the Exclusion Zone or the Contaminant Reduction Zone. Do not permit personnel to have facial hair that interferes with a proper fit of the respirator.

E. Respiratory Protection:

1. Furnish on-Site personnel with extensive training in the usage and limitations of, and qualitative fit testing for, air purifying and supplied-air respirators in accordance with 29 CFR 1910.134.
2. Develop, implement, and maintain a written respiratory program in accordance with 29 CFR 1910.134.
3. Monitor, evaluate, and provide respiratory protection for on-Site personnel.
4. Levels of protection as listed in Paragraph 1.7 C have been chosen to be consistent with the Site-specific potential airborne hazards associated with the major contaminants identified at the Site. The selection of appropriate protection is based upon the potential presence of compounds with the lowest recommended threshold limit value.
5. In the absence of additional air monitoring information or substance identification, the following minimum levels of respiratory protection shall be required:

<i>Sustained Total Organic Vapor Concentration Above Background (ppm)</i>	<i>Level of Respiratory Protection Required</i>
<5	Half- or full-facepiece respirator available
5 to 50	Half-facepiece air-purifying respirator, Level C
50 to 250	Full-facepiece air-purifying respirator, Level C
>250	Shut down activities, evaluate the need for Level B or higher respiratory protection

6. Immediately notify CRA when level of respiratory protection required increases from Level D to Level C or from Level C to Level B.

7. Be responsible for appropriate respiratory protection during work activities. Do not allow persons to enter the Exclusion Zone or the Contaminant Reduction Zone without appropriate respiratory protection.
  8. Be responsible for assessing the ability for on-Site personnel to wear respiratory protection. Cardiopulmonary system examination and pulmonary function testing are minimum requirements for personnel wearing respiratory protection.
  9. Do not permit on-Site personnel unable to pass a respirator fit test to wear respiratory protection and to enter the Exclusion Zone or the Contaminant Reduction Zone.
- F. Heat Stress/Cold Stress: Implement a heat stress and/or cold stress monitoring program as applicable and include in the Site-specific Health and Safety Plan.
- G. Personnel Hygiene and Personnel Decontamination Procedures: Provide, as a minimum, the following:
1. Suitable containers for storage and disposal of used disposable PPE.
  2. Potable water and a suitable sanitation facility.
- H. Emergency and First-Aid Equipment:
1. Locate and maintain emergency and first-aid equipment in appropriate location on the Site, including:
    1. First-aid kit to accommodate the numbers of on-Site personnel.
    2. Portable emergency eye wash.
    3. Two 20-pound ABC type dry chemical fire extinguishers.
    4. Blankets and towels.
    5. Stretcher.
    6. One hand-held emergency siren.
  2. As a minimum, provide 1 certified first-aid technician on the Site at all times that on-Site work activities are in progress. This technician may perform other duties but shall be immediately available to render first aid when needed.
- I. Site Communications:
1. Post emergency numbers near the Site telephones.
  2. Ensure that personnel work under the use of a "buddy" system and develop a hand signal system appropriate for the Site activities.
  3. Provide an employee alarm system to notify employees of on-Site emergency situations or to stop work activities if necessary.

4. Furnish selected personnel with 2-way radios.

- J. Safety Meetings: Conduct mandatory daily safety meetings for on-Site personnel, and additionally as required by special or work-related conditions; include refresher training for existing equipment and protocols, review ongoing safety issues and protocols, and examine new Site conditions as they are encountered. Hold additional safety meetings on an as-needed basis.
- K. Custodian: Employ and assign to the Works a person who shall report directly to the Health and Safety Officer and who shall be responsible for keeping safety equipment and facilities clean, properly equipped, and maintained, herein referred to as "Custodian". The Custodian may perform other duties for CONTRACTOR but the Custodian's first priority shall be maintenance of protective equipment and the personnel decontamination area.

#### 1.9 AIR MONITORING

- A. Develop air monitoring program meeting the requirements of 29 CFR 1910.120 (h) and 29 CFR 1926.65 (h) and minimally meet the requirements of the text below.
- B. During the progress of project activities, periodic monitoring of particulate levels and organic vapor levels will be taken by the HSO.
- C. The following air monitoring instrumentation will be used for this purpose. A photoionization detector.
- D. All monitoring equipment will be calibrated on a daily basis in accordance with the manufacturer's guidelines, and such calibrations will be recorded in the Site daily log book. Results of all daily air monitoring also will be recorded in the Site daily log book and copies are to be given to the CRA.
- E. Air monitoring will be conducted hourly in the breathing zone of the workers in the EZ or as deemed necessary by the HSO based on Site-specific conditions. Background measurements immediately upwind of the EZ will be taken before activities commence.
- F. Immediately upon identifying sustained elevated levels of organic vapor greater than 250 parts per million (ppm) within the EZ, the air monitoring results will be reported to the CRA and work activities will be shut down. The HSO will determine the cause of the sustained elevated levels of organic vapors and alternate work methods or engineering controls will be implemented to rectify the release of the elevated concentrations of organic vapors, or upgrade levels of PPE as required.
- G. A personnel air monitoring program shall be implemented by CONTRACTOR for workers having the highest potential for exposure to chemicals present on Site. Samples would be collected during the startup of activities, at locations where personnel would face potential exposure to selected chemicals of concern. Samples will be collected and analyzed for the presence of the compounds of concern as determined by CONTRACTOR. Appropriate NIOSH procedures and methods will be followed and all samples are to be sent to an American Industrial Hygiene Association (AIHA) accredited laboratory. Results of the air sampling program will be posed for personnel to review.

1.10 CONTINGENCY AND EMERGENCY RESPONSE PLANS

- A. General: Comply with 29 CFR 1910.120 (I) and 20 CFR 1926.65 (I).
- B. On-Site Contingency and Emergency Response Plan: Address the standard operating procedures to be implemented during emergency situations.

1.11 SITE CONTROL

- A. Comply with 29 CFR 1910.120 (d) and 20 CFR 1926.65 (d).
- B. Provide in the Site-specific Health and Safety Plan a figure or map which presents the delineation of the work zones for Project activities.
- C. Provide in the Site-specific Health and Safety Plan a discussion on Site security issues.
- D. Provide in the Site-specific Health and Safety Plan a detailed discussion on decontamination procedures for both equipment and personnel, including collection and disposal of wash waters, sediments, and spent PPE.
- E. Construct a decontamination pad for use during excavation of contaminated materials and backfilling in accordance with Section 01000.
- F. Construct temporary fencing surrounding the perimeter of the excavation and fill areas to be maintained until vegetation cover is established as specified in Section 02921.

END OF SECTION

## SECTION 01571

### TEMPORARY SOIL EROSION AND SEDIMENT CONTROL

#### 1.1 SECTION INCLUDES

- A. References.
- B. Progress submittals.
- C. Quality assurance.
- D. Qualifications.
- E. Regulatory requirements.
- F. Pre-installation meeting.
- G. Delivery, storage, and handling.
- H. Environmental requirements.
- I. Sequencing and scheduling.
- J. Products.
- K. Examination.
- L. Preparation.
- M. Installation.
- N. Field quality control.
- O. Cleaning.

#### 1.2 REFERENCES

- A. Section 01000 - General Requirements: Requirements for references.
- B. ASTM International (ASTM):
  - 1. D6461 - Standard Specification for Silt Fence Materials.
  - 2. D6462 - Standard Practice for Silt Fence Installation.

1.3 QUALITY ASSURANCE

- A. Perform work of this Section in accordance with the State of Kentucky and City of Louisville MSD erosion and sediment control regulations and the Erosion Protection and Sediment Control Plan prepared by CRA.

1.4 REGULATORY REQUIREMENTS

- A. CRA will provide certificate of compliance from MSD indicating approval of the Soil Erosion and Sediment Control Plan.

1.5 PRE-INSTALLATION MEETING

- A. Section 01000 - General Requirements: Requirements for pre-installation meeting.
- B. Convene 1 week prior to commencing work of this Section.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Section 01000 - General Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Protect silt fence materials from chemicals, physical damage, direct sunlight, or other conditions or substances that may degrade the product.
- C. Deliver, store, and handle in accordance with manufacturer's instructions.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Section 01000 - General Requirements: Requirements for temporary controls.
- B. Maintain soil erosion and sediment control features during and after installation.

1.8 SEQUENCING AND SCHEDULING

- A. Section 01000 - General Requirements: Requirements for coordination.
- B. Temporary erosion control measures shall be in place and functional prior to initiation of earth work activities.

1.9 PRODUCTS

- A. Stone Bag Check Silt/Velocity Check Dam: In accordance with Louisville and Jefferson County Metropolitan Sewer District (MSD) Standard Drawing No. EF-12-01.

B. Silt Fence:

1. An assembled, ready to install unit consisting of geotextile attached to driveable posts.
2. Geotextile: Uniform in texture and appearance with no defects, flaws, or tears that would affect its physical properties. Contain sufficient ultraviolet ray inhibitor and stabilizers to provide a minimum 2-year service life from outdoor exposure.
3. Net Backing:
  1. Wire fence fabric, minimum 14 gage, maximum 6-inch mesh spacing, joined to the geotextile at both top and bottom with double stitching of heavy-duty cord.
  2. Width of Netting: Minimum of 3 feet.
4. Posts: Sharpened wood 4 x 4 inches square and protrude below the bottom of geotextile to allow a minimum of 2 feet embedment. Post spacing not to exceed 24 feet and steel T or U type, weight of 1 pound per linear foot; or 2 x 4 hardwood post, spacing 8 feet. Securely fasten each post to the geotextile and net backing by staples suitable for such purpose.

1.10 EXAMINATION

- A. Section 01000 - General Requirements: Verification of existing conditions before starting work.
- B. Verify surface water drainage pattern to ensure proper locating of soil erosion and sediment control features.
- C. Verify that surfaces and Site conditions are ready to receive work.

1.11 PREPARATION

- A. Preserve salient natural features, keep cut-fill operations to a minimum, and ensure conformity with topography so as to create the least erosion and to adequately handle the volume and velocity of surface water runoff.
- B. Whenever feasible, retain, protect, and supplement natural vegetation.
- C. Do not damage, degrade, or in any way cause harm to existing aboveground structure or appurtenance, below-ground utility, pipe, conduit, cable, conductor, or structure.
- D. Performance of temporary erosion control work does not relieve CONTRACTOR of his responsibility for preventing or minimizing the potential for erosion or siltation.

1.12 INSTALLATION

- A. Construct temporary erosion control items in conformity with the typical sections and elevation controls in accordance with the approved Soil Erosion and Sediment Control Plan.
- B. Install silt fence in accordance with ASTM D6462.

- C. Check weekly and after each rainfall greater than 0.5 inches erosion and sediment control measures.
- D. Silt fence and/or stone bag check dams may be removed at the beginning of the work day, but replace at the end of the work day.
- E. Whenever sedimentation is caused by stripping vegetation, regrading, or other development, remove it from all adjoining surfaces, drainage systems, and watercourses, and repair damage as quickly as possible.
- F. Prior to or during construction, CRA may require the installation or construction of improvements to prevent or correct temporary conditions on Site. Improvements may include berms, mulching, sediment traps, detention and retention basins, grading, planting, retaining walls, culverts, pipes guardrails, temporary roads, and other measures appropriate to the specific condition. All temporary improvements shall remain in place and in operation until otherwise directed by CRA.
- G. Repair damaged bales, end runs, and undercutting beneath bales.
- H. If fence fabric tears, starts to decompose, or in any way becomes ineffective, replace the affected portion immediately.
- I. Unless otherwise shown on the Drawings, or directed by CRA, remove all items upon completion of the Works. Spread accumulated sediments to form a suitable surface for seeding or dispose of, and shape the area to permit natural drainage; all to the satisfaction of CRA. All materials once removed become the property of CONTRACTOR.

#### 1.13 FIELD QUALITY CONTROL

- A. Section 01000 - General Requirements: Field inspection.
- B. CRA will inspect all temporary erosion control items for proper placement and maintenance.
- C. Repairs ordered by CRA caused by circumstances not under CONTRACTOR's control after acceptance will be compensated for at Contract rates or as extra work in the absence of comparable items of work. Material used in restoring any original temporary erosion control installation, after the original installations were accepted, will be measured and added to the quantities originally installed.

#### 1.14 CLEANING

- A. Clean silt fences of excessive sediment accumulation if and when necessary.
- B. Remove sediment deposits when the level of deposition reaches approximately one-half the height of the barrier.

END OF SECTION

## SECTION 02072

### VFPE LINER

#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES

- A. VFPE liner for landfill cap.

##### 1.2 REFERENCES

- A. Section 01000 - General Requirements: Requirements for references.
- B. ASTM International (ASTM):
  - 1. D638 - Standard Test Method for Tensile Properties of Plastics.
  - 2. D698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
  - 3. D792 - Standard Test Methods for Density and Specific Gravity (Relative Density) of Plastic by Displacement.
  - 4. D1004 - Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting.
  - 5. D1238 - Standard Test Method for Flow Rates of Thermoplastics by Extrusion Plastometer.
  - 6. D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.
  - 7. D1603 - Standard Test Method for Carbon Black in Olefin Plastics.
  - 8. D3895 - Test Method for Oxidative Induction Time of Polyolefins by Thermal Analysis.
  - 9. D4218 - Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds by the Muffle-Furnace Technique.
  - 10. D4437 - Standard Practice for Determining the Integrity of Field Seams Used in Joining Flexible Polymeric Sheet Geomembranes.
  - 11. D4439 - Terminology for Geosynthetics.
  - 12. D4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
  - 13. D5199 - Standard Test Method for Measuring Nominal Thickness of Geotextiles and Geomembranes.
  - 14. D5321 - Standard Test Method for Determining the Coefficient of Soil and Geosynthetic or Geosynthetic and Geosynthetic Friction by the Direct Shear Method.

15. D5596 - Test Method for Microscopic Evaluation of the Dispersion of Carbon Black in Polyolefin Geosynthetics.
16. D5721 - Practice for Air-Oven Aging of Polyolefin Geomembranes.
17. D5885 - Test Method for Oxidation Induction Time of Polyolefin Geosynthetic by High Pressure Differential Scanning Calorimetry.
18. D5994 - Test Method for Measuring the Core Thickness of Textured Geomembranes.
19. D6392 - Standard Test Method for Determining the Integrity of Nonreinforced Geomembrane Seams produced using Thermo-Fusion Method.

C. Geosynthetic Research Institute (GRI):

1. Test Method GM6 - Pressurized Air Channel Test for Dual Seamed Geomembranes.
2. Test Method GM9 - Standard Practice for Cold Weather Seaming on Geomembranes.
3. Test Method GM11 - Accelerated Weathering of Geomembranes Using a Fluorescent UVA-Condensation Exposure Device.
4. Test Method GM12 - Measurement of Asperity Height of Textured Geomembranes Using a Depth Gage.
5. Test Method GM17 - Test Properties, Testing Frequency and Recommended Warranty for Linear Low Density Polyethylene (LLDPE) Smooth and Textured Geomembranes.

### 1.3 DEFINITIONS

- A. VFPE: Very flexible polyethylene.
- B. FML: Flexible membrane liner means VFPE.
- C. SMDD: Standard Maximum Dry Density means the maximum dry unit weight determined in accordance with ASTM D698.
- D. Wrinkles: Corrugations in FML which will fold over during placement of materials overlying FML.
- E. Minimum Average Value: Average of test values calculated in accordance with specified standard at minimum frequency specified in GRI Test Method GM17.
- F. Conform to ASTM D4439 for interpretation of terms used in this Section.

### 1.4 PROGRESS SUBMITTALS

- A. Section 01000 - General Requirements: Requirements for progress submittals.

- B. Samples: A representative Sample at least 1 foot by the full FML roll width, no later than 14 days prior to ordering.
- C. Product Data: Submit no later than 14 days prior to ordering.
- D. Manufacturer's Installation Instructions: Submit at least 14 days prior to installation.
- E. Manufacturer's Certificate: Submit the following based on GRI Test Method GM17 test frequency:
1. Certificates pertaining to the FML rolls of material delivered to the Site shall accompany the rolls. Each roll shall be identified by a unique manufacturing number. The quality control certificate shall include results of at least the following tests: density, carbon black content, thickness, tensile strength, puncture resistance, and tear resistance. The quality control certificates shall be signed by a responsible party employed by the manufacturer.
  2. Certificates pertaining to raw materials and manufactured rolls shall be provided by the FML manufacturer. ENGINEER will review the test results for completeness and for compliance with the required minimum properties for both the raw materials and manufactured FML rolls. Materials and rolls which are in non-compliance with the minimum required properties will be rejected.
- F. Daily Field Installation Report: Submit no later than 1 day following date covered by report. Include:
1. Subgrade surface acceptance form signed by manufacturer's representative.
  2. Total amount, type, and location of FML placed.
  3. Identifiers of rolls and fabricated blankets correlated with manufacturer's number.
  4. Quality control tests of materials used during the day.
  5. Total amount and location of seams completed, identification of seamer, and welding equipment used.
  6. Changes in layout drawings.
  7. Observations of test seams, including seaming unit number and identification of names of seamers, weather conditions, speed, temperature setting, and results.
  8. Location and results of non-destructive testing.
  9. Location and results of destructive testing.
  10. Reasons for and observations of repairs and retesting, including locations, type of repair, name of repairer, and seaming equipment or product used.
  11. Observations of anchor trench excavation, backfilling, and compaction.
  12. Observations of field seaming operations, including weather conditions, cleaning, overlaps, rate of seaming, names of seamers, and units used.

13. Observations of seams around appurtenances, and connection to appurtenances.
- G. Layout Drawings: Drawings of the proposed FML placement pattern. Provide no later than 14 days prior to installation.
- H. Installer Qualifications: Submit a copy of the manufacturer's approval letter or license to ENGINEER no later than 14 days prior to installation.
- I. Manufacturer's Qualifications: Submit no later than 10 days prior to ordering list of previous projects totaling 3 million square feet of installation, and 5 projects including name of project, description of project, area, client's name and address, contacts, and telephone numbers; engineer's name, address, contact, and telephone number; installer's name, address, contact, and telephone number; and date installed.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Section 01000 - General Requirements: Requirements for closeout submittals.
- B. Record Documents: Indicate panel layout, including panel identifiers.
- C. Warranties: Completed original warranty forms filled out in OWNER's name and registered with manufacturer.

#### 1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 20 projects, 25 million sq ft installed, and 3 years documented experience.
- B. Installer:
1. Trained and qualified to install the type of FML to be used for the project, and an approved and/or licensed installer of FML manufacturer. Submit a copy of the approval letter or license.
  2. Personnel performing seaming operations shall be qualified by experience or by successfully passing seaming tests.
  3. At least 1 seamer shall have experience seaming at least 10 million square feet of FML of the same generic type as FML used for the project using the same type of seaming method. This master seamer shall provide direct supervision over apprentice seamers.
  4. Apprentice seamers shall be qualified by attending training sessions taught by the master seamer and performing at least 2 successful seaming tests under similar weather conditions using the seaming method used for production seaming.

#### 1.7 PRE-INSTALLATION MEETING

- A. Convene 1 week prior to commencing installation of FML.

B. Purpose of Meeting:

1. Define the responsibilities of each party.
2. Establish lines of authority and lines of communication.
3. Review Site-specific quality assurance/quality control and monitoring procedures.
4. Define the method of acceptance of the completed liner.
5. Establish rules for writing on the liner (i.e., who is authorized to mark on the liner and in what colors).
6. Review time schedules.
7. Review PPE and applicable regulations.
8. Review safety plan and procedures.
9. Review panel layout and numbering system for panels, seams, and test samples.
10. Review methods of measuring production.
11. Review procedures for incremental acceptance.
12. Review procedures for initiating and implementing change orders.
13. Visit the Site for review of surface preparation, physical location of the Site, and Site access.
14. Review critical design details.

1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01000 - General Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Package and label FML rolls or blankets prior to shipment to the Site. The label shall indicate FML manufacturer, type of FML, thickness, lot number, roll number, and roll dimensions.
- C. When transported to the Site, handle FML rolls or blankets by appropriate means so that no damage is caused, as recommended by FML manufacturer.
- D. Protect FML liner from direct sunlight and heat to prevent degradation of FML material and adhesion of individual whorls of a roll.
- E. Take adequate measures to keep FML materials away from possible deteriorating sources (i.e., vandalism, theft).
- F. Use appropriate handling equipment when moving rolled or folded FML from one place to another.

- G. Notify ENGINEER 3 days in advance of FML delivery to the Site. Perform joint inspection with ENGINEER upon delivery. Defects or damage from shipping and handling will be grounds for rejection of a portion of FML or of the entire FML roll at the discretion of ENGINEER. Remove roll from the Site and replace with new material.

#### 1.9 ENVIRONMENTAL REQUIREMENTS

- A. Section 01000 - General Requirements: Requirements for temporary controls.
- B. Install FML in accordance with manufacturer's instructions.
- C. Suspend installation operations whenever climatic conditions, as determined by ENGINEER or manufacturer's representative, are unsatisfactory for placing FML to the requirements of this Section.
- D. Weather Conditions for FML Placement:
  - 1. Comply with manufacturer's recommendation.
  - 2. Do not unroll, unfold, or place FML at an ambient temperature below 32 degrees F or above 104 degrees F, unless CONTRACTOR obtains written approval from FML liner manufacturer and ENGINEER.
  - 3. Install on dry ground.
  - 4. FML placement shall take into account Site drainage, wind direction, cap construction, access to the Site and production schedule of the Works.
  - 5. FML placement shall not proceed if subgrade conditions have deteriorated due to moisture, or in the presence of high winds, as determined by ENGINEER, which might damage the FML.
  - 6. Deployed FML should be adequately ballasted at all times to limit the risk of wind damage.
- E. Weather Conditions for FML Seaming:
  - 1. Comply with manufacturer's recommendations.
  - 2. Make no weld below 34 degrees F unless:
    - 1. CONTRACTOR strictly follows the guidelines for field seaming of FML in cold weather, as identified in GRI Test Method GM9.
    - 2. CONTRACTOR obtains written approval from FML manufacturer to weld at temperature below 32 degrees F in accordance with GRI Test Method GM9.
  - 3. Between 34 degrees F and 50 degrees F, seaming is possible if FML is preheated by either sun or hot air device, and if there is not excessive cooling resulting from wind.
  - 4. Make no weld below 5 degrees F.

5. In all cases, FML must be dry while being welded.

#### 1.10 SEQUENCING AND SCHEDULING

- A. Section 01000 - General Requirements: Requirements for coordination.
- B. Coordinate the installation of FML with surface preparation work and installation of structures which will penetrate the FML.

#### 1.11 MANUFACTURER'S WARRANTY

- A. Provide 5-year manufacturer's warranty against manufacturing defects.
- B. Warranty: Include coverage for:
  1. Defective product found to be not in compliance with the requirements of this Section.
  2. Replacement of the FML with new material including costs associated with FML installation.
- C. Fill out original warranty forms in OWNER's name and register with manufacturer.

### PART 2 PRODUCTS

#### 2.1 FML

- A. Manufactured from virgin resin with no more than 10 percent rework. Rework shall be of same formulation as the parent material. No post consumer resin permitted.
- B. Design and manufacture rolls specifically for the purpose of fluid containment.
- C. Free of holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter.
- D. Melt index value less than 1.0 g/10 minutes in accordance with ASTM D1238.
- E. Textured membrane shall have uniform texturing appearance, free from agglomerated texturing and defects that may affect the specified properties.
- F. Complying with the specifications listed in Article 2.2.

## 2.2 FML PROPERTIES

A. Conform to the following specifications:

<i>Property</i>	<i>Unit</i>	<i>Test Method</i>	<i>Minimum Average Value<sup>(1)</sup></i>
Thickness	mil	ASTM D5994	40
• Lowest of 10 coupon values			36
• Lowest of 8 of 10 coupon values			34
Density	g/cu cm	ASTM D1505/D792	0.939 (maximum)
Tensile Strength at Break	pounds per inch	ASTM D638 Type IV Dumbbell, 2 ipm	60
Asperity Height	mil	GRI Test Method GM12	10
Elongation at Break	percent	ASTM D638 Type IV Dumbbell, 2 ipm Gage lengths of 50 mm	250
Carbon Black Content	percent	ASTM D1603	2 to 3 (range)
Carbon Black Dispersion for 10 Different Views		ASTM D5596	Cat 1 or 2
• 9 in Categories 1 or 2 and 1 in Category 3			
Puncturing Resistance	pound	ASTM D4833	44
Tear Resistance	pound	ASTM D1004	22
Oxidation Induction Time (OIT)			
• Standard	minute	ASTM D3895	100
• High Pressure	minute	ASTM D5885	400
Oven Aging at 85 degrees C	NA	ASTM D5721	NA
• Standard OIT retained after 90 days; or	percent	ASTM D3895	35
• High Pressure OIT retained after 90 days	percent	ASTM D5885	60
UV Resistance <sup>(2)</sup>			
• High Pressure OIT retained after 1,600 hours	percent	ASTM D5885	35

Notes:

- (1) Except as indicated.
- (2) 20-hour UV cycle at 75 degrees C, followed by 4 hours condensation at 60 degrees C.
- (3) Mean value determined by manufacturer's quality control testing.

## 2.3 SOURCE QUALITY CONTROL

- A. Section 01000 - General Requirements: Requirements for source testing and analysis of FML.
- B. Manufacturer shall perform test for parameters shown in Article 2.2 at a minimum frequency specified in GRI Test Method GM17.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01000 - General Requirements: Verification of existing conditions before starting work.
- B. Obtain ENGINEER's and manufacturer's approval in writing prior to installing FML and prior to placing subsequent layers on FML.
- C. Coordinate activities such that ENGINEER can observe testing. ENGINEER will observe all testing and collect Samples for destructive laboratory testing.

### 3.2 PREPARATION

- A. Surface Preparation:
  1. Do not begin installation of FML liner until a proper subbase has been prepared and approved by ENGINEER and FML manufacturer. The prepared surface shall be free from abrupt changes in grade, water, loose earth, exposed rocks, rubble, protrusions, vegetation, and other foreign matter which may be damaging to FML. Place FML bedding (Soil Type S2) in 1 layer to a minimum compacted depth of 4 inches, compact uniformly to a minimum of 95 percent SMDD and smooth with a drum roller.
  2. Do not place FML liner in an area which has become softened by precipitation and which will not support liner installation equipment without rutting.

### 3.3 PANEL PLACEMENT

- A. Designate each roll or blanket with an individual panel number and correlate with manufacturer's identification number. Mark each designation in each roll as it is deployed. Position FML liner on the Site as shown on the layout drawings. A panel is the unit area of in-place membrane which is to be seamed (i.e., 1 roll may be cut into several panels). Follow manufacturer's instructions on the wrapping containing FML liner materials to assure the panels are unrolled or unfolded in the proper direction for seaming. Unroll or unfold only the panels

which are to be anchored or seamed together that day. Exercise care not to damage FML liner during this operation. Require workers to wear shoes which will not damage FML liner.

- B. Minimize pulling of FML liner panels to reduce permanent tension.
- C. Minimize dragging of textured FML to prevent damage to texturing.
- D. Take the following precautions to minimize the risk of damage by wind during panel placement:
  - 1. Orientate work according to the direction of prevailing winds if possible, unless otherwise specified.
  - 2. Provide adequate securement of FML liner panels to prevent uplift by wind, using sand bags, tires, or any other means which will not damage FML liner. Along the edges, ensure loading is continuous, to avoid possible windflow under the panels.
- E. Replace panels which, in the judgment of ENGINEER, become seriously damaged (torn or twisted permanently). Repair less serious damage in accordance with Article 3.6.
- F. Do not proceed with FML liner placement when raining or in an area of ponded water.
- G. Install FML roll so that there will be no corrugations or folds at the average expected temperature of the final use condition.

#### 3.4 INSTALLATION AROUND APPURTENANCES

- A. Install FML liner around wells, vents, or other appurtenances protruding through FML liner as shown on Drawings. Unless otherwise specified, initially install FML liner skirt around each appurtenance prior to the FML liner installation. After FML liner has been placed and seamed, complete the final field seam connection between the appurtenance skirt and the FML liner. Maintain a sufficient initial overlap of the appurtenance skirt so that shifts in location of FML liner can be accommodated.
- B. Obtain ENGINEER's written approval for materials to be used to seal gaps between the liner skirt and appurtenances.
- C. Perform installation on rough surfaces carefully to minimize FML liner damage. Additional loosely placed FML liner sections may be used by FML liner installer as protection for FML liner, if approved by ENGINEER.
- D. Ensure clamps, clips, bolts, nuts, or other fasteners used to secure FML liner around each appurtenance have a lifespan equal to or exceeding FML liner.

#### 3.5 FIELD SEAMING

- A. Overlap the panels a minimum of 4 inches for extrusion welds and a minimum of 5 inches for hot wedge welds.
- B. Panel Preparation: Prior to seaming, clean the seam area and ensure it is free of moisture, dust, dirt, debris of any kind, and foreign material.

- C. Seaming Equipment and Products: Seam FML liner using extrusion or hot wedge welding equipment and installation methods recommended by manufacturer. Where extrusion welding is used, the composition of the extrudate shall be identical to the liner material, or all panels shall be welded together using the hot wedge welding system. Extrusion welding equipment shall include thermometers measuring the temperature of the extrudate in the machine extruder and at the nozzle. Wedge welding equipment used shall be capable of continuously monitoring and controlling the wedge temperature.
- D. The direction of seaming on slopes shall be such that the flow of water over top of FML liner is not hindered. Orient seams downslope. Specifically, for hot welded seams FML liner overlap shall be on the downslope side of the seam. Extend seaming to the outside edge of panels to be placed in the anchor trench.
- E. If the supporting soil is yielding, provide a firm substrate by using a homogeneous board, a conveyor belt, or similar hard surface directly under the seam overlap to effect proper rolling pressure.
- F. Seaming Wrinkles: Cut fishmouths and corrugations so as to effect a flat overlap. Seam the cut fishmouths or wrinkles as well as possible, and then install patch of the same generic FML liner extending a minimum of 6 inches beyond the cut in all directions.
- G. No cross-slope seam shall occur less than 5 feet from the toe of slope unless slope is less than 10 percent. Cross-slope seams may be utilized if cut at an angle of approximately 45 degrees.
- H. Label each seam with date, seamer, equipment seaming temperature and speed, and time seam started and completed.
- I. Seaming Tie-ins: Seaming of FML tie-ins shall not proceed unless all panels to be seamed are at a uniform temperature (i.e., early in the morning or late in the day) so as to avoid excessive distortion in the liner due to FML contraction and expansion.

### 3.6 REPAIR PROCEDURES

- A. Clean and dry surfaces at the time of repair.
- B. Repair pinholes by applying a patch, and defective seams by reseaming, flap welding, or applying a patch, as approved by ENGINEER.
- C. Repair tears, blisters, larger holes, undispersed raw materials, and contamination by foreign matter, or corrugations determined by ENGINEER to be excessive, by patches.
- D. Patches:
  - 1. Abrade surfaces as appropriate.
  - 2. Label each patch with date, number, and seamer and equipment.
  - 3. Ensure patches are round or oval in shape.
  - 4. Make of the same generic FML liner.

5. Extend patch a minimum of 4 inches beyond the edge of defects.

### 3.7 INSTALLATION OF MATERIALS IN CONTACT WITH FML LINER

- A. Place cover material in a manner so as not to damage FML liner.
- B. Place FML bedding (Soil Type 5/2) in accordance with FML manufacturer's recommendation.

### 3.8 FIELD QUALITY CONTROL

- A. Section 01000 - General Requirements: Field inspection and testing.
- B. Inspect each panel after placement and prior to seaming for damage. Mark damaged panels or portions of damaged panels which have been rejected, as judged by ENGINEER, and record their removal from the work area.
- C. Verify that weather conditions (air temperature, non-excessive wind, and lack of precipitation) are acceptable for panel placement.
- D. Field Seaming Operations: Verify that:
  1. Seaming personnel have the specified qualifications.
  2. Overlaps meet specified requirements.
  3. Seaming area is clean and dry, as specified.
  4. A hard substrate such as a board or a piece of conveyor belt is used if the supporting soil is soft or uneven.
  5. Seaming equipment is available and meets specified requirements.
  6. Weather conditions for seaming are acceptable, as specified.
  7. Seaming procedures as specified are followed.
  8. Panels are properly positioned to prevent wrinkling.
  9. Equipment for testing seams is available on the Site and operational.
  10. Field tensiometer has been correctly calibrated.
- E. Test Seams:
  1. Perform test seams in accordance with ASTM D4437 to verify that the seaming conditions are adequate. Conduct test seams at the discretion of ENGINEER and at least 2 times each day (at the beginning of the day and at least 4 hours thereafter) for each seaming equipment used that day. Perform test seaming under the same conditions as production seaming. Extrusion weld test seams shall be at least 4 feet long. Hot wedge weld test

seams shall be at least 10 feet long. Perform test seams on scrap FML not to be incorporated into the Works.

2. Cut 1-inch wide coupons from the test seam and assign to peel or shear test alternatively as they are cut across panel. Test coupons in shear and peel using a calibrated field tensiometer.
  1. Minimum strength of FML liner test seams when tested in shear shall be 1,200 psi, calculated by dividing the force at break by the specimen width and nominal sheet thickness.
  2. Minimum strength of FML liner test seams when tested in peel shall be 1,000 psi, calculated by dividing the force at break by the specimen width and nominal sheet thickness.
  3. In addition, the test coupons must not delaminate. Passing test results must be obtained from 4 of 5 coupons when tested in shear, and 4 of 5 coupons when tested in peel. For FML liner test seams performed using a hot wedge welder, perform peel tests on both the inside and outside welds; both welds must pass the peel test. If a test seam fails, reject the seaming equipment for field seaming until the deficiencies are corrected and a successful test seam is produced.
3. A passing test seam will be an indicator of the adequacy of the seaming unit and seamer working under prevailing Site conditions, but not necessarily an indicator of field seam adequacy.
4. Coordinate completion of test seams such that ENGINEER can observe such seams. ENGINEER will observe all test seams. Retain a Sample from each test and label with the date, ambient temperature, number of seaming unit, seamer, and pass or fail description. One half of the Sample will be retained by ENGINEER.

F. Non-destructive Seam Testing:

1. Non-destructively test field seams over their full length by pressure testing in accordance with GRI Test Method GM6. Pressure test results will be written on liner near seam. Number or otherwise designate each seam. Record location, date, test unit, name of tester, and outcome of all non-destructive testing.
2. Passing non-destructive test of field seams, meeting or exceeding the requirement in GRI Test Method GM6, indicates the adequacy of field seams, subject to the results of destructive seam testing, as identified in Paragraph 3.8 G.
3. Coordinate activities such that ENGINEER can observe all testing. ENGINEER will observe all testing. Non-destructive testing performed in absence of ENGINEER shall be repeated. Conduct testing as the seaming work progresses, not at the completion of all field seaming. Number and mark all defects found during testing immediately after detection. Repair, retest, and remark all defects found to indicate completion of the repair and acceptability. If pressure testing is performed, following testing, the hole resulting from the pressure needle must be repaired.

- G. Destructive Seam Testing: Collect FML field seam samples at a frequency of approximately 1 sample per 500 linear feet of field seam, or more frequently if requested by ENGINEER, at

locations indicated by ENGINEER. Field test 5 coupons in peel and 5 coupons in shear in accordance with ASTM D4437, using a calibrated field tensiometer. Perform peel tests on the inside and outside weld. If at least 4 of each of the 5 coupons do not delaminate and pass the tensile strength requirements, based on the field testing, then collect additional 2-foot long sample from the same location and provide to ENGINEER for quality assurance laboratory shear and peel testing. Minimum shear strength of FML liner field seams when tested in shear shall be 1,200 psi calculated by dividing the force at break by the specimen width and nominal sheet thickness for both the field and laboratory tests. Minimum strength of FML liner field seams when tested in peel shall be 1,000 psi calculated by dividing the force at break by the specimen width and nominal sheet thickness for both the field and laboratory tests. If either field or laboratory tests fail, isolate the defective seam and re-test as follows:

1. Collect additional samples from the field seam for testing using a field tensiometer, within 10 feet of each side of the failing sample as determined by ENGINEER, until passing test locations are identified. Collect additional 2-foot long sample from each passing field test location and provide to ENGINEER for laboratory shear and peel testing.
2. Repair the field seam between the passing test locations (based on field tensiometer results) by extrusion welding or patching.
3. Non-destructively test the patch or extrusion weld and repair, as required, until non-destructive test standards are achieved.
4. If the additional laboratory shear or peel tests fail, then additional destructive seam field samples will be collected and field tested to isolate the failing seam, then laboratory tested.
5. Repeat the above-noted procedure until passing field and laboratory test results are achieved, thereby delineating extent of defective seam.

#### H. Verification of Seams in Special Locations:

1. Non-destructively test seams in special locations (i.e., appurtenances) if the seam is accessible to testing equipment. ENGINEER will observe all seam testing operations. If the seam cannot be tested in place, it will be observed by ENGINEER and CONTRACTOR for uniformity and completeness.
2. In the case of visual inspections, record the seam number, date of inspection, name of tester, and outcome of the inspection.
3. Promptly repair, retest, and re-mark defective seams to indicate completion of the repair.

#### I. Defects and Repairs:

1. Identification: Inspect seams and non-seam areas of FML liner for identification of defects, holes, blisters, undispersed raw materials, and any sign of contamination by foreign matter.
2. Evaluation: Non-destructively test each suspect location, both in seam and non-seam, using the methods described in Paragraph 3.8 F. Mark and repair each location which fails the non-destructive testing.
3. Verification of Repairs: Non-destructively test each repair using the method described in Paragraph 3.8 F. Tests which pass the non-destructive test standards will serve as an

indication of an adequate repair. Re-repair and test failed tests locations until a passing test results. Record the number of each repair, date, location, repair personnel initials, and test outcome. ENGINEER will observe non-destructive testing of repairs.

J. FML Liner Acceptance: FML liner will be accepted by ENGINEER when:

1. Installation is finished.
2. Documentation of installation is completed and submitted to ENGINEER.
3. Verification of the adequacy of field seams and repairs, and associated testing, is complete.

K. Quality Assurance Testing by ENGINEER: Quality assurance laboratory engaged by OWNER will perform laboratory tests on FML liner samples as identified in this Section to determine if FML liner seams meet specified requirements. Copies of test reports will be supplied to CONTRACTOR on request. Retesting of previously failed FML liner seams will be at no additional cost to OWNER.

### 3.9 MANUFACTURER'S FIELD SERVICES

- A. Manufacturer shall provide a qualified representative to observe placement of FML liner, subgrade preparation, FML liner installation, and backfilling operations. Manufacturer's representative shall guide the installer into proper installation techniques but shall not assume liability or responsibility in the overall installation.
- B. Manufacturer's representative shall have extensive knowledge of FML liner product, specifically as it pertains to proper construction techniques for waste management applications.
- C. Manufacturer's representative shall remain on the Site until, in his opinion, CONTRACTOR and/or installer can adequately complete the installation in strict accordance with specifications and the installation procedure specified in this Section.

### 3.10 PROTECTION OF FINISHED WORK

- A. Section 01000 - General Requirements: Requirements for protecting installed work.
- B. Protect finished work from damage.
- C. Do not permit traffic over unfinished liner installation.

END OF SECTION



## SECTION 02073

### DRAINAGE GEOCOMPOSITE

#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES

- A. Drainage geocomposite (geonet) for landfill cap.

##### 1.2 REFERENCES

- A. Section 01000 - General Requirements: Requirements for references.
- B. ASTM International (ASTM):
  - 1. D422 - Standard Test Method for Particle Size Analysis of Soils.
  - 2. D698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
  - 3. D1505 - Standard Test Method for Density of Plastics by the Density-Gradient Technique.
  - 4. D1603 - Standard Test Method for Carbon Black in Olefin Plastics.
  - 5. D4218 - Standard Test Method for Determination of Carbon Black Content in Polyethylene Compounds By the Muffle-Furnace Technique.
  - 6. D4439 - Standard Terminology for Geosynthetics.
  - 7. D4491 - Standard Test Methods for Water Permeability of Geotextiles by Permittivity.
  - 8. D4595 - Standard Test Method for Tensile Properties of Geotextiles by the Wide-Width Strip Method.
  - 9. D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles.
  - 10. D4716 - Standard Test Method for Constant Head Hydraulic Transmissivity (In-Plane Flow) of Geotextiles and Geotextile Related Products.
  - 11. D4751 - Standard Test Method for Determining Apparent Opening Size of a Geotextile.
  - 12. D4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products.
  - 13. D5261 - Standard Test Method for Measuring Mass Per Unit Area of Geotextiles.
  - 14. D7005 - Standard Test Method for Determining the Bond Strength (Ply Adhesion) of Geocomposites.

15. F904 - Standard Test Methods for Comparison of Bond Strength of Ply Adhesion of Similar Laminates Made From Flexible Materials.

- C. Geosynthetic Research Institute (GRI) GC7 - Determination of Adhesion and Bond Strength of Geocomposites.

### 1.3 DEFINITIONS

- A. Geotextile: Synthetic filter fabric for use in geotechnical filter applications.
- B. HDPE: High density polyethylene.
- C. Drainage Geocomposite: Synthetic HDPE drainage net material with prefastened geotextile fabric for use as a drainage layer.
- D. Wrinkles: Corrugations which will fold over during placement of overlying material.
- E. MD: Machine Direction.
- F. CD: Cross Direction.
- G. SMDD: Standard Maximum Dry Density and in the context of this Contract means the maximum dry unit weight determined in accordance with ASTM D698.
- H. Conform to ASTM D4439 for interpretation of terms used in this Section.

### 1.4 PROGRESS SUBMITTALS

- A. Section 01000 - General Requirements: Requirements for progress submittals.
- B. Samples: A representative Sample at least 2 feet by roll width no later than 14 days prior to ordering.
- C. Product Data: Submit no later than 14 days prior to ordering. Include installation, handling, storage, and repair instructions.
- D. Manufacturer's Certificates:
  1. Certificates pertaining to the rolls of material delivered to the Site shall accompany the rolls. Each roll shall be identified by a unique manufacturing number and shall reference the specific rolls of geotextile fabric and gridded HDPE geonet incorporated into the drainage net construction.
  2. Include test data for all parameters specified in PART 2.
  3. The quality control certificates shall be signed by a responsible party employed by drainage geocomposite manufacturer and shall be notarized.
  4. Certificates pertaining to raw materials and manufactured drainage geocomposite rolls shall be provided from drainage geocomposite manufacturer. ENGINEER will review the

test results for completeness and for compliance with the required minimum properties for both the raw materials and manufactured drainage geocomposite rolls. Materials and rolls which are in non-compliance with the minimum required properties will be rejected.

- E. Daily Field Installation Reports: Provide daily reports of the following:
1. Total amount and location of drainage geocomposite placed.
  2. Identifiers of rolls and fabricated blankets.
  3. Quality control tests of materials used during the day.
  4. Total amount and location of seams completed.
  5. Seaming procedures used.
  6. Changes in layout drawings.
  7. Location and type of repairs.
  8. Observations of seams around appurtenances and connection to appurtenances.
- F. Layout Drawings: Provide drawings of the proposed drainage geocomposite placement pattern and field seams no later than 14 days prior to installation. Indicate panel configuration and location of seams.
- G. Manufacturer's Installation Instructions: Submit no later than 14 days prior to installation.
- H. Installer Qualifications: Submit a copy of manufacturer's approval letter or license no later than 14 days prior to commencing installation.
- I. Manufacturer's Qualifications: Submit, no later than 14 days prior to ordering, a list of previous projects including name of project, description of project, area, client's name and address, contacts, and telephone numbers; engineer's name, address, contact, and telephone number; installer's name, address, contact, and telephone number; and date installed.
- J. Transmissivity Testing Reports: Submit no later than 14 days prior to ordering.
- 1.5 CLOSEOUT SUBMITTALS
- A. Section 01000 - General Requirements: Requirements for closeout submittals.
- B. Record Documents: Indicate panel layout, including panel identifiers, date placed, installer's name, location of seams, and location and details of repairs.
- C. Warranties: Completed original warranty forms filled out in OWNER's name and registered with manufacturer.

## 1.6 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 10 projects, 10 million square feet, manufacturing, and 3 years documented experience.
- B. Installer: Trained and qualified to install the type of drainage geocomposite to be used for the project and an approved and/or licensed installer of drainage geocomposite manufacturer with minimum 5 projects, 5 million square feet installation, and 3 years experience. Submit a copy of the approval letter or license to ENGINEER.
- C. Seamers: Personnel performing seaming operations shall be qualified by experience with a minimum of 3 years experience.

## 1.7 PRE-INSTALLATION MEETING

- A. Section 01000 - General Requirements: Requirements for pre-installation meeting.
- B. Convene 1 week prior to commencing work of this Section.
- C. Purpose of Meeting:
  - 1. Define the responsibilities of each party.
  - 2. Establish lines of authority and lines of communication.
  - 3. Establish Site-specific quality control and monitoring procedures.
  - 4. Define installation procedures.
  - 5. Define the method of acceptance of the completed drainage geocomposite.
  - 6. Define installation schedule.
  - 7. Discuss submittals.
  - 8. Review methods for measuring production.
  - 9. Review methods for protecting installed work.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Section 01000 - General Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Package and label drainage geocomposite rolls or blankets prior to shipment to the Site. The label shall indicate drainage geocomposite manufacturer, type of drainage geocomposite, and roll or blanket number.

- C. When transported to the Site, handle drainage geocomposite rolls or blankets in accordance with manufacturer's instructions so that no damage is caused.
- D. Protect drainage geocomposite from direct sunlight and heat to prevent degradation of drainage geocomposite material and adhesion of individual whorls of a roll or layers of blanket.
- E. Take adequate measures to keep drainage geocomposite materials away from possible deteriorating sources.
- F. Use handling equipment approved by manufacturer when moving rolled or folded drainage geocomposite from one place to another.
- G. Notify ENGINEER 3 days in advance of drainage geocomposite delivery to the Site. Perform joint inspection with ENGINEER upon delivery. Defects or damage will be grounds for rejection of a portion or of an entire roll at the discretion of ENGINEER. Remove roll from the Site and replace with new material. Repair minor damage and other defects as directed by ENGINEER.

#### 1.9 ENVIRONMENTAL REQUIREMENTS

- A. Section 01000 - General Requirements: Requirements for temporary controls.
- B. Install drainage geocomposite in accordance with manufacturer's installation instructions.
- C. Suspend installation operations whenever climatic conditions, as determined by ENGINEER, are unsatisfactory for placing drainage geocomposite to the requirements of this Section.
- D. Weather Conditions for Seaming: Comply with manufacturer's installation instructions.

#### 1.10 SEQUENCING AND SCHEDULING

- A. Section 01000 - General Requirements: Requirements for coordination.
- B. Coordinate the installation of drainage geocomposite with liner installation.

#### 1.11 MANUFACTURER'S WARRANTY

- A. Provide 5-year manufacturer's warranty against manufacturing defects.
- B. Warranty: Include coverage for:
  - 1. Defective products found to be not in compliance with the requirements of this Section.
  - 2. Replacement of the drainage geocomposite with new material including costs associated with drainage geocomposite installation.
- C. Fill out original warranty forms in OWNER's name and register with manufacturer.

## PART 2 PRODUCTS

### 2.1 MANUFACTURERS

- A. Tenax Corporation or approved equal.

### 2.2 DRAINAGE GEOCOMPOSITE

- A. Incorporate a prefabricated gridded HDPE drainage net made of overlapping polyethylene strands which transmits fluids in the plane of the net.
- B. Incorporate a nonwoven geotextile fabric prefastened to the top surface of HDPE drainage net and a nonwoven geotextile fabric prefastened to the bottom surface of HDPE geonet.
- C. Complying with the specifications listed in Paragraphs 2.2 D, 2.2 E, and 2.2 F.
- D. Geotextile fabric shall conform to acceptable values listed as follows:

<i>Property</i>	<i>Unit</i>	<i>Test Method</i>	<i>Acceptable Value</i>
Fabric Weight	ounce per sq yd	ASTM D5261	5.6 (minimum)
Grab Strength (MD/CD)	pound	ASTM D4632	170 (minimum)
Grab Elongation (MD/CD)	percent	ASTM D4632	50 (maximum)
Permittivity	sec <sup>-1</sup>	ASTM D4491	1.5 (minimum)
Puncture Strength	pound	ASTM D4833	90 (minimum)
Apparent Opening Size (AOS)	Sieve Size mm	ASTM D4751	70 (maximum) 0.210 (maximum)

- E. Drainage net shall comply with the following specifications:

<i>Property</i>	<i>Unit</i>	<i>Test Method</i>	<i>Minimum Acceptable Value</i>
Density	g/cc	ASTM D1505	0.94
Carbon Black Content	percent	ASTM D1603 or ASTM D4218	2.0
Tensile Strength (MD)	pounds per inch	ASTM D5035	75

- F. Drainage geocomposite shall comply with the following specifications:

<i>Property</i>	<i>Unit</i>	<i>Test Method</i>	<i>Minimum Acceptable Value</i>
Ply Adhesion	pounds per inch	GRI GC7 and ASTM F904 Modified or ASTM D7005	1.0

## 2.3 SOURCE QUALITY CONTROL

- A. Section 01000 - General Requirements: Requirements for source testing.
- B. Drainage geocomposite shall have the following minimum flow rate capacities when tested in accordance with ASTM D4716 at 1,000 pounds per sq ft confining pressure and sandwiched between the materials to be used in the cap. Perform transmissivity testing at gradients of 0.10 and 0.20

<i>Gradient</i>	<i>Minimum Transmissivity after 14 Days Confining Pressure</i>
0.10	$7.13 \times 10^{-4} \text{ m}^2/\text{s}$
0.20	$9.9 \times 10^{-5} \text{ m}^2/\text{s}$

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01000 - General Requirements: Verification of existing conditions and work area restrictions before starting work.
- B. Obtain ENGINEER's approval prior to installing drainage geocomposite and prior to placing subsequent materials on drainage geocomposite.

### 3.2 PREPARATION

- A. Prior to placement of drainage geocomposite, ensure underlying surfaces are smooth. The surface shall provide a firm, unyielding foundation for drainage geocomposite with no sudden, sharp, or abrupt changes or break in grade.
- B. Obtain written approval of surface on which drainage geocomposite is to be installed from manufacturer's field representative prior to placing drainage geocomposite and prior to placing overlying materials.

### 3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Place individual sheets and/or strips of drainage geocomposite side by side without gaps.

- C. Lay drainage geocomposite smooth and free of tension, folds, or wrinkles.
- D. Protect properly placed drainage geocomposite from displacement or damage until and during placement of overlaid materials.
- E. In the presence of wind, secure drainage geocomposite with sandbags until overlying cover materials are installed.
- F. Ensure that the underlying materials are not damaged during placement of drainage geocomposite.
- G. Ensure that stones, mud, and soil are not entrapped in the drainage geocomposite during and following placement and/or seaming operations.
- H. Anchor drainage geocomposite and roll down the slope in such a manner as to continually keep the material in tension.
- I. Overlap geotextile fabric prefastened to the drainage geocomposite to adjoining section of drainage geocomposite in accordance with manufacturer's instructions; bond by thermal methods, or by sewing in accordance with manufacturer's instructions.
- J. If sewing is performed, use thread polymeric material with chemical resistance similar to the geotextile.
- K. Drainage net may be butt joined or lapped, except for joints perpendicular to slope direction on slopes shall be overlapped at least 2 feet.
- L. Apply nylon/plastic cable ties to the net edge at 5-foot intervals along the edge.
- M. Make end splices as follows: On slopes, overlap the upslope sheet 2 feet over the downslope sheet and apply 2 rows of cable ties. Space ties at 2 feet and stagger spacing in the 2 rows.
- N. Install drainage geocomposite around wells or other structures in accordance with manufacturer's written specifications.
- O. Stagger horizontal seams on side slopes between rolls.

### 3.4 REPAIR PROCEDURES

- A. Geotextile:
  - 1. Clean and dry surfaces at the time of repair.
  - 2. Repair holes or tears in geotextiles by patching with the same geotextile.
  - 3. Patches: Minimum of 12 inches larger in all directions than the area to be repaired, and spot bonded thermally.

B. Drainage Geocomposite:

1. Clean and dry surfaces at the time of repair.
2. Repair holes or tears in the drainage net by patching with the same drainage net.
3. Patches: Minimum of 12 inches larger in all directions than the area to be repaired. Tie the patch in place using a minimum of 4 nylon cable ties.

3.5 INSTALLATION OF MATERIALS IN CONTACT WITH DRAINAGE GEOCOMPOSITE

- A. Cover drainage geocomposite with a minimum of 12 inches of cover soil.
- B. Place soil cover materials in a manner so as not to damage drainage geocomposite, and in accordance with drainage geocomposite manufacturer's instructions.
- C. Cover material placement equipment shall push the cover material in front of it, traveling only on the previously placed cover material, never directly on drainage geocomposite. No sudden turns or accelerations which may abrade the covered drainage geocomposite shall occur while equipment is directly above drainage geocomposite.
- D. Minimize slippage of drainage geocomposite and assure that no tensile stress is induced in the materials.

3.6 FIELD QUALITY CONTROL

- A. Section 01000 - General Requirements: Field inspection.
- B. Inspect each panel in place for damage, tears, overlaps, and consistency before placing material thereon. Mark damaged panels or portions of damaged panels which have been rejected, as judged by ENGINEER, and record their removal from the work area. Repair or replace damaged or improperly placed sections as judged by ENGINEER.

3.7 MANUFACTURER'S FIELD SERVICES

- A. Manufacturer shall provide a qualified representative to observe installation of drainage geocomposite.
- B. Manufacturer's representative shall have extensive knowledge of drainage geocomposite liner product, specifically as it pertains to proper construction techniques for waste management applications.
- C. Manufacturer's representative shall be on the Site for a minimum of first week of installation and shall remain on the Site until, in its opinion, CONTRACTOR and/or installer can adequately complete the installation in strict accordance with specifications and the installation procedure specified in this Section.

3.8 PROTECTION OF FINISHED WORK

- A. Section 01000 - General Requirements: Requirements for protecting installed work.
- B. Protect finished work from damage.
- C. Do not permit traffic or construction equipment directly on drainage geocomposite.

END OF SECTION

## SECTION 02074

### GEOTEXTILE

#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES

- A. Geotextile for access road.
- B. Geotextile for toe of cap and sub-drain pipe.

##### 1.2 REFERENCES

- A. Section 01000 - General Requirements: Requirements for references.
- B. ASTM International (ASTM): D4873 – Standard Guide for Identification, Storage and Handling of Geotextile.

##### 1.3 DEFINITIONS

- A. Geotextile: Synthetic fabric for use in geotechnical filter, separation, stabilization, or erosion control applications.

##### 1.4 PROGRESS SUBMITTALS

- A. Section 01000 - General Requirements: Requirements for progress submittals.
- B. Samples: Submit a representative sample at least 2 feet by roll width for each type of geotextile no later than 10 days prior to ordering.
- C. Product Data: Submit no later than 10 days prior to delivery to the Site.
- D. Manufacturer's Installation Instructions: Submit at least 14 days prior to installation.
- E. Manufacturer's Certificates: Certificates pertaining to the rolls of material delivered to the Site shall accompany the rolls. Each roll shall be identified by a unique manufacturing number. The quality control certificate shall include results of at least the following tests: unit weight, tensile strength, elongation at break, Mullen Burst strength, puncture strength, permittivity, apparent opening size, and ultraviolet stability. The quality control certificates shall be signed by a responsible party employed by the manufacturer and shall be notarized. Materials and rolls which are in non-compliance with the minimum required properties will be rejected.
- F. Daily Field Installation Report. Submit no later than 1 day following date covered by report. Included, but not limited to the following:
  - 1. Total amount and location of geotextile placed.
  - 2. Identifiers of rolls.
  - 3. Changes in layout drawings.

4. Record of defects caused during transportation and handling.
5. Observations of repairs, including locations and name of repairer.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Section 01000 - General Requirements: Requirements for closeout submittals.
- B. Warranties: Completed original warranty forms filled out in OWNER's name and registered with manufacturer.

#### 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Section 01000 - General Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Deliver geotextile bearing manufacturer's seals and labels intact. Clearly label each roll to show geotextile identification, date of manufacture, lot number, analysis of contents, and special instructions.
- C. Store and handle geotextile in accordance with manufacturer's recommendations and ASTM D4873.
- D. Notify ENGINEER 3 days in advance of delivery to the Site. Perform joint inspection with ENGINEER upon delivery. Defects or damage from shipping and handling will be grounds for rejection of a portion of geotextile or of the entire geotextile roll at the discretion of ENGINEER. Remove roll from the Site and replace with new material.

#### 1.7 ENVIRONMENTAL REQUIREMENTS

- A. Section 01000 - General Requirements: Requirements for temporary controls.
- B. Install geotextile in dry conditions and in accordance with manufacturer's instructions.
- C. Suspend installation operations whenever climatic conditions, as determined by ENGINEER, are unsatisfactory for placing geotextile to the requirements of this Section.

#### 1.8 SEQUENCING AND SCHEDULING

- A. Section 01000 - General Requirements: Requirements for coordination.
- B. Coordinate installation of geotextile with surface preparation.

#### 1.9 MANUFACTURER'S WARRANTY

- A. Provide 5-year manufacturer's warranty against manufacturing defects.

- B. Warranty: Include coverage for:
  - 1. Defective product found to be not in compliance with the requirements of this Section.
  - 2. Replacement of geotextile with new material including costs associated with geotextile installation.
- C. Fill out original warranty forms in OWNER's name and register with manufacturer.

## PART 2 PRODUCTS

### 2.1 GEOTEXTILE

- A. Geotextile for Access Road: Woven, Type 2044 Propex Fabrics Inc.
- B. Geotextile for Toe of Cap and Sub-drain: Nonwoven, needle-punched 8 ounce/square yard Type 4508 Propex Fabrix Inc.

### 2.2 SOURCE QUALITY CONTROL

- A. Section 01000 - General Requirements: Requirements for source testing and analysis of geotextile.
- B. Manufacturer Quality Control:
  - 1. Sample and test geotextile material, at a minimum, once every 100,000 sq ft for unit weight, tensile strength, elongation, hydraulic burst strength, puncture strength, and trapezoid tear strength to demonstrate that the material conforms to requirements specified for geotextile Type Amoco 4508. Test for UV stability and apparent opening size, at a minimum, once every month
  - 2. Sampling shall, in general, be performed on sacrificial portions of the material such that repair of the material is not required.
  - 3. If geotextile sample fails to meet the quality control requirements of this Section, sample and test each roll manufactured in the same lot, or at the same time, as the failing roll. Sampling and testing of rolls shall continue until a pattern of acceptable test results is established.
  - 4. At geotextile manufacturer's discretion and expense, additional testing of individual rolls may be performed to more closely identify the non-complying rolls and/or to qualify individual rolls.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01000 - General Requirements: Verification of existing conditions before starting work.
- B. Verify that surfaces and the Site conditions are ready to receive work.

### 3.2 PREPARATION

- A. Prior to geotextile placement, where possible roll the surface with a smooth drum steel or pneumatic roller so as to be free of irregularities, loose earth, and abrupt changes in grade. Provide the necessary equipment and personnel to maintain an acceptable supporting surface during fabric installation.
- B. Examine geotextile for defects including rips, holes, flaws, deterioration, or damage incurred during manufacture, transportation, or handling.
- C. Remove defective or damaged geotextile.
- D. Prepare anchor trenches in accordance with the Drawings.

### 3.3 INSTALLATION

- A. Notify ENGINEER at least 24 hours in advance of intention to commence placement of geotextile.
- B. Do not permit placement of overlay materials until ENGINEER has inspected and approved installation of geotextile.
- C. Obtain approval of ENGINEER prior to installation of geotextile.
- D. Place the geotextile on a prepared base as shown on the Drawings.
- E. Unfold or unroll geotextile in accordance with manufacturer's instructions, directly on the prepared base, in conditions which will prevent damage to both the geotextile and the base grade. Unsuitable conditions include, but are not limited to moderate to high wind conditions.
- F. Overlap dimensions and the method of joining adjacent sheets shall, as a minimum, be in conformance with manufacturer's instructions. Secure geotextile to the base grade in accordance with manufacturer's instructions and as shown on the Drawings.
- G. During placement of geotextile, do not entrap stones in the geotextile.
- H. Do not expose geotextiles to sunlight for more than 14 days, or less if recommended by manufacturer.
- I. Position and deploy geotextile to minimize handling. Lay smooth and free of tension, stress, folds, or creases. Protect properly placed geotextile from displacement, contamination by surface runoff, or damage, until and during placement of overlaid materials.
- J. Place geotextile on sloping surfaces in one continuous length.
- K. Do not permit passage of vehicular traffic directly on geotextile at any time.
- L. Place geotextile by unrolling onto graded surface and retain in position as specified.
- M. Remove and replace damaged or deteriorated geotextile as directed by ENGINEER.

### 3.4 FIELD QUALITY CONTROL

- A. Section 01000 - General Requirements: Field inspection and testing.
- B. ENGINEER will inspect geotextile in place for tears, overlaps, and consistency before placing materials thereon. Damaged sections, as judged by ENGINEER, will be marked and their removal from the work area recorded.
- C. ENGINEER will verify that weather conditions (air temperature, non-excessive wind, and lack of precipitation) are acceptable for panel placement.

END OF SECTION



## SECTION 02117

### MATERIAL HANDLING AND ON-SITE TRANSPORTATION

#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES

- A. Loading, handling, unloading, temporary storage, and on-Site transportation of contaminated and non-contaminated materials.

##### 1.2 SYSTEM DESCRIPTION

- A. This Section applies to planning, and providing equipment and services necessary to decontaminate the equipment and to load, transport, unload, stage (as necessary), and handle the following materials:
  - 1. Clearing and grubbing debris (contaminated and non-contaminated).
  - 2. Impacted soil from designated areas (contaminated).
  - 3. Construction materials (contaminated and non-contaminated).
  - 4. Liquids (contaminated and non-contaminated).

##### 1.3 ENVIRONMENTAL REQUIREMENTS

- A. Section 01000 - General Requirements: Requirements for temporary controls.
- B. Safeguards and Protective Barriers:
  - 1. Provide protective barriers to minimize the spread of contamination during handling. Items may include tarpaulin on a wooden frame to protect the side of the truck during loading, plastic sheeting on the ground during loading and unloading, and dump ramps during unloading to protect the undercarriage.
  - 2. Provide appropriate safeguards (e.g., bump guards, signs) as necessary.
- C. Where monitored air particulate levels exceed specified limits during transportation of contaminated materials, implement additional emission control measures to reduce emissions below specified limits.
- D. Do not spill, leak, or otherwise release materials from transport vehicles and containers.
- E. Do not generate dusting conditions when handling bulk solids.
- F. Do not generate fume or misting conditions when handling bulk liquids.
- G. Clean up any and all spills or leaks in transit.

## PART 2 PRODUCTS

### 2.1 VEHICLES AND CONTAINERS

- A. Excavators, vehicles, and containers used for contaminated materials shall be labeled to indicate that they are dedicated solely for use with contaminated materials.
- B. Excavator Buckets, Containers, Truck Beds and Roll-on/Roll-off Boxes:
  - 1. Free from drain holes, cracks, or other conditions that might allow leakage of materials.
  - 2. Free from conditions that might allow waste to accumulate.
  - 3. Sealed and/or fully lined to prevent leakage.
  - 4. Covers to prevent accumulation of rain water or release of dust.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01700 - Execution Requirements: Verification of existing conditions before starting work.
- B. Verify that surfaces and the Site conditions are ready to receive work.

### 3.2 MATERIAL HANDLING AND ON-SITE TRANSPORTATION

- A. General:
  - 1. Take necessary precautions for safe operation of the equipment and protection of the public, workers, and the environment from injury and damage from equipment. Operators shall be properly licensed.
  - 2. Equipment and tools associated with contaminated materials shall be used exclusively for that purpose until released. Items shall be decontaminated in accordance with Paragraph 3.2 E prior to release off the Site or for use with non-contaminated materials.
  - 3. Keep a log in each truck recording the following information for each trip:
    - 1. Date and time of loading.
    - 2. Area from which the contaminated material was obtained.
    - 3. Area at which the material was unloaded.
    - 4. Quantity (e.g., approximate cubic yards, approximate weight, or specific number of containers).

5. Date and time of unloading.
  4. When not in use, secure vehicles in the secured excavation support areas, with keys removed and doors locked. Security shall be solely the responsibility of CONTRACTOR.
- B. Loading for on-Site Transportation:
1. Inspect containers and haulage trucks before loading at the excavation support areas to verify that no water or liquid has been introduced and the vehicle/container has not been damaged. Test seals on watertight containers on a weekly basis to confirm seals are watertight. Maintain a log of seal testing.
  2. Containerize material at the excavation support area.
  3. Use protective barriers and take care to prevent spreading contamination.
  4. Install and secure truck bed covers over non-containerized material. Secure tailgates during transit.
  5. Decontaminate vehicles before leaving the work area. Collect and transport sediment removed from vehicles and equipment for on-Site disposal.
- C. On-Site Transportation:
1. Transport containerized material to the stockpile area.
  2. Control free water from materials to prevent spreading contamination along the haul roads and other areas during transport. Do not track contaminated or non-contaminated material onto clean areas or transportation routes.
  3. Collect, pump, and transport potentially contaminated water to on-Site Wastewater Treatment Facility. This includes water from excavations, stockpile pads, and equipment decontamination pad. Control water handling to prevent accidental spills in accordance with Section 01000.
  4. Do not deviate from the on-Site transportation routes approved by CRA without prior written approval by CRA.
  5. In the event of accidents, spills, or releases, comply with Paragraph 3.2 F.
  6. Reinstall truck bed covers on haul trucks for return trips to prevent dust being blown from the truck. Decontaminate the vehicles prior to leaving any contaminated work areas.
- D. Unloading:
1. Unload contaminated materials at the area designated by CRA in a manner that will prevent spillage onto clean areas. Use appropriate safeguards (e.g., flagpersons, bump guards).
  2. Conduct placement of materials into designated areas under direction of CRA. Do not place hazardous materials, if any, without approval of CRA.

3. Do not permit runoff from waste material to migrate off Site.
  4. In the event of oncoming precipitation, heavy winds or other extreme weather conditions, as a minimum, cover materials with synthetic cover materials adequately weighted down to protect it from runoff and migration. Dispose synthetic cover materials on Site, in location designated by CRA.
  5. Reinstall truck bed covers on haul trucks for return trips to prevent dust being blown from the truck. Decontaminate the vehicles prior to leaving any contaminated work areas.
- E. Decontamination:
1. Decontaminate equipment that has been in contaminated areas. Complete gross decontamination by removing packed dirt, grit, and debris from the exterior, underbody, and between tires before leaving a contaminated area. Remove packed dirt, grit, and debris using scrapers, brushes, rags, or similar means. Comply with Section 01500.
  2. Collect and dispose of materials removed from vehicles/containers in designated area on Site.
  3. Use decontamination areas only for light and final decontamination and not for gross decontamination (e.g., removal of bulk visible materials by scraper, brushes). Perform gross decontamination, if required, as part of earthwork at the area where trucks are loaded or unloaded. Repeat decontamination as needed.
  4. Visually inspect decontaminated vehicles and maintain log of inspections at the Site. Provide decontamination inspection log to CRA on a daily basis.
- F. Spills and Accidents: Notify CRA and implement the appropriate response immediately upon learning of an accident, spill, or release of contaminated material.

### 3.3 FIELD QUALITY CONTROL

- A. Section 01000 - General Requirements: Field inspection and testing.
- B. CRA will provide inspection of the following aspects of the Works:
1. Material loading.
  2. Material transfer.
  3. Haul road conditions including dust control.
  4. Equipment decontamination.
  5. Health, safety, and personal hygiene.
  6. Air monitoring.

END OF SECTION

## SECTION 02200

### SITE PREPARATION

#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES

- A. Removal and disposal of surface debris.
- B. Clearing and grubbing.
- C. Removal, salvage, and storage of designated fencing.
- D. Removal of riprap swale.
- E. Extension of existing gas vents.

##### 1.2 DEFINITIONS

- A. Clearing: Felling, trimming, and cutting of trees into sections and the satisfactory disposal of trees and other vegetation designated for removal, including down timber, snags, brush, and rubbish occurring in the areas to be cleared.
- B. Grubbing: Removal and disposal of stumps, roots larger than 3 inches in diameter, and matted roots from the designated grubbing areas.

##### 1.3 QUALITY ASSURANCE

- A. Comply with permits, certificates, and licenses for the execution of the Works. Comply with Laws and Regulations relating to the performance of the Works.

##### 1.4 ENVIRONMENTAL REQUIREMENTS

- A. Section 01000 - General Requirements: Requirements for temporary controls.
- B. Control the amount of dust resulting from operations to avoid creation of a nuisance in the surrounding area.

#### PART 2 PRODUCTS

- A. Extend existing gas vents as shown on Drawings to match existing materials as directed by CRA.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01000 - General Requirements: Verification of existing conditions before starting work.
- B. Verify that existing plant life or other surface features designated to remain are tagged or identified.

### 3.2 PREPARATION

- A. Protect trees, plant growth, utilities, and surface features designated to remain from damage incident to clearing, grubbing, and construction operations by the erection of barriers or by such other means as circumstances require.
- B. Prepare the on-Site disposal areas for placing removed materials.
- C. Remove existing fencing as required to gain access to perimeter areas and store until completion of earthworks and then reinstall as specified in Section 02821.

### 3.3 CLEARING AND GRUBBING

- A. Clear areas required for access to Site and execution of Works.
- B. Cut off trees, stumps, roots, brushes, and other vegetation in areas to be cleared, flush with or below the original ground surface, except such trees and vegetation as shown on Drawings or directed by CRA to be left standing.
- C. Remove and dispose of structures that obtrude, encroach upon, or otherwise obstruct work.
- D. Remove trees and shrubs within work areas. Remove stumps and root system to a depth of 6 inches and to a depth required by the Works.
- E. When directed by CRA, remove trees and stumps that are designated as trees from areas outside those areas designated for clearing and grubbing; fell such trees, remove their stumps and roots, and dispose of the trees.
- F. Clear undergrowth and deadwood, without disturbing subsoil.
- G. Fill depressions made by grubbing with suitable material and compact to in accordance with Section 02316 to make the surface conforms to the original adjacent surface of the ground.
- H. Remove debris, rock, and extracted plant life.
- I. Chip trees, logs, stumps, roots, brush, rotten woods, and other vegetation with diameter less than 3 inches obtained from the clearing and grubbing operations and stockpile wood chips to be used in erosion control.
- J. Chip or remove and dispose off Site all logs, trees, and branches with diameters between 3 and 6 inches.

### 3.4 SECURITY FENCE REMOVAL AND REINSTALLATION

- A. Remove designated security fence, posts, and gates from areas shown on the Drawings. Salvage fence if quality, as determined by CRA, is acceptable for reinstallation.
- B. Dispose of fence, posts, and gates not suitable for reuse, as determined by CRA.
- C. Store salvaged fence, posts, and gates so that they are protected from damage during the Works. Replace materials damaged by CONTRACTOR at no additional cost to OWNER.
- D. Maintain security of the Site during removal and reinstallation of existing fence.
- E. Reinstall the fence in accordance with Section 02821.
- F. Repair damaged galvanized surfaces in accordance with Section 02821.

### 3.5 REMOVAL OF RIPRAP SWALE

- A. Removing riprap and piping from Area 3.
- B. Place removed materials in CRA designated areas.

### 3.6 WASTE HANDLING

- A. Collect solid waste generated during removal and abandonment activities and dispose in designated area on Site.
- B. Collect liquid wastes generated during removal and abandonment activities and equipment cleaning, and transfer to designated storage tanks.

END OF SECTION



## SECTION 02316

### FILL

#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES

- A. Site filling and backfilling.
- B. Fill for over-excavation.
- C. Fill for landfill cap.
- D. Aggregate for new access road, geonet daylighting, and pipe enveloping.
- E. Riprap for stabilized construction entrance area.
- F. Compaction as scheduled.

##### 1.2 REFERENCES

- A. Section 01000 - General Requirements: Requirements for references.
- B. ASTM International (ASTM):
  - 1. C88 - Standard Test Method for Soundness of Aggregates by Use of Sodium Sulfate or Magnesium Sulfate.
  - 2. C117 - Standard Test Method for Materials Finer than 75- $\mu$ m (No. 200 Sieve) in Mineral Aggregates by Washing.
  - 3. C127 - Standard Test Method for Specific Gravity and Absorption of Coarse Aggregate.
  - 4. C136 - Standard Test Method for Sieve Analysis of Fine and Coarse Aggregates.
  - 5. C666 - Standard Test Method for Resistance of Concrete to Rapid Freezing and Thawing.
  - 6. D422 - Standard Test Method for Particle-Size Analysis of Soils.
  - 7. D698 - Test Method for Laboratory Compaction Characteristics of Soil Using Standard Effort (12,400 ft-lbf/ft<sup>3</sup> (600 kN-m/m<sup>3</sup>)).
  - 8. D2216 - Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock.
  - 9. D2487 - Standard Classification of Soils For Engineering Purposes (Unified Soil Classification System).

10. D2974 - Standard Test Method for Moisture, Ash and Organic Matter of Peat and Other Organic Soils.
  11. D3740 - Standard Practice for Minimum Requirements for Agencies Engaged in the Testing and/or Inspection of Soil and Rock as Used in Engineering Design and Construction.
  12. D4318 - Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils.
  13. D4972 - Standard Test Methods For pH of Soils.
  14. D5084 - Standard Test Methods for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter.
  15. D6938 - Standard Test Method for In-Place Density and Water Content of Soil and Soil-Aggregate by Nuclear Methods (Shallow Depth).
- C. State of Kentucky Transportation Cabinet Standard Specifications for Road and Bridge Construction.
- D. United States Environmental Protection Agency (USEPA): SW-846 - Test Methods for Evaluating Solid Wastes, Physical/Chemical Methods, Third Edition and Promulgated Updates I-III.

### 1.3 DEFINITIONS

- A. SMDD: Standard Maximum Dry Density and in the context of this Contract means the maximum dry unit weight determined in accordance with ASTM D698.
- B. 'State Standard' in this Section shall mean State of Kentucky Transportation Cabinet Standard Specifications for Road and Bridge Construction.

### 1.4 PROGRESS SUBMITTALS

- A. Section 01000 - General Requirements: Requirements for progress submittals.
- B. Materials Sources: Submit name of proposed imported soil materials sources at least 14 days prior to commencing transport of materials to the Site.
- C. Geotechnical and Chemical Data: At least 7 days prior to commencing transport of materials to the Site, submit geotechnical data for source testing as specified in Article 2.7 for each type of imported fill.
- D. Independent Geotechnical and Analytical Testing Firm: At least 14 days prior to commencing transport of imported fill to the Site, submit the name and qualifications of the independent testing firms proposed by CONTRACTOR to provide testing services for work of this Section.
- E. Suppliers' Certificates: Submit certificate indicating that each type of imported fill meets or exceeds specified requirements.
- F. Material Source Certification: If fill materials will be obtained from a state certified quarry, chemical characterization specified in Paragraph 2.7 E may not be required. CONTRACTOR

shall be responsible to submit to CRA documentation related to the quarry operations that includes but is not limited to the following:

1. State certification.
  2. Quarry location and address.
  3. Owner's name and state permit/licensing number.
  4. Reports of testing in accordance with specified standards, evidencing compliance with specified requirements.
  5. Historical report information pertaining to the quarry certification.
  6. Quarry Quality Assurance Plan identifying sampling procedures, sample network, analytical procedures, and analytical laboratory.
  7. Statement from the quarry declaring there is no contamination in the fill materials proposed for the Project, and providing evidence that the source is clean. Fill materials will be considered uncontaminated if chemical analysis have been completed by a state-certified laboratory in accordance with EPA Contract Laboratory Program (CLP) protocol for parameters specified in Paragraph 2.7 E and the most recent test results for every fill material proposed for the Project show that the every fill material is at or below natural background levels for the region.
- G. Weigh Tickets: Submit at the start of the work day following delivery weigh tickets generated at Supplier's weigh scale of imported fill delivered to the Site.
- H. Weigh Scale Calibration: Submit no later than 7 days prior to commencing transport of materials to the Site a calibration chart, completed within the previous 6 months, for weigh scale. Weigh scale shall be calibrated by State of Kentucky agency.
- I. Field Quality Control: Submit field data on same day testing is performed. Submit laboratory data within 24 hours of completion of test.

## 1.5 QUALIFICATIONS

- A. Independent Geotechnical Testing Firm: Company specializing in performing the work of this Section and complying with ASTM D3740 to perform testing of fill material samples including density, moisture content, permeability and particle size analysis.
- B. Independent Laboratory: Company specializing in performing the work of this Section to perform chemical analysis of fill material samples for parameters specified in Paragraph 2.7 E.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Section 01000 - General Requirements: Requirements for transporting, handling, storing, and protecting products.

- B. Deliver, handle, and transport soil materials at all times in a manner and with equipment that will prevent intermixing of soil and aggregate types, segregation, or contamination.
- C. Minimize stockpiling requirements. Transport material from source directly to final position where possible.

## 1.7 ENVIRONMENTAL REQUIREMENTS

- A. Section 01000 - General Requirements: Requirements for temporary controls.
- B. Suspend operations whenever climatic conditions, as determined by CRA, are unsatisfactory for placing fill to the requirements of this Section.
- C. After occurrence of heavy rains, do not operate equipment on previously placed material or on approved surfaces until the material has dried sufficiently to prevent occurrence of excessive rutting.
- D. Do not place fill in a frozen state or against frozen surfaces or frozen previously placed material. Do not place fill on snow, ice, water, or other objectionable material or on improperly prepared surfaces or previously placed material.
- E. Where surfaces or previously placed material have been softened or eroded, remove soft and yielding material or otherwise objectionable or damaged areas and replace with compacted fill as specified by CRA.
- F. Decontaminate equipment involved in grading activities that may have come in contact with potentially contaminated material before being removed from the Site or being relocated to clean areas of the Site.

## PART 2 PRODUCTS

### 2.1 GENERAL

- A. Imported from an approved source.
- B. Free of unsuitable materials including:
  - 1. Frozen material or material containing snow or ice.
  - 2. Trees, stumps, branches, roots, or other wood or lumber.
  - 3. Wire, steel, cast iron, cans, drums, or other foreign material.
  - 4. Materials containing hazardous or toxic constituents at hazardous or toxic concentrations.
- C. Compactable to specified density at specified moisture content.

## 2.2 SOIL TYPE S1 (COMMON FILL)

- A. Graded.
- B. Free of rocks larger than 2 inches, organic matter, very soft clays, swelling clays, or fine uniform sands that may be difficult to compact.
- C. ASTM D2487 Group Symbol: Any except CH, MH, OL, and OH.

## 2.3 SOIL TYPE S2 (Protective Soil Cover and VFPE Bedding Layer)

- A. Select soil to be used as FML bedding layer that is approved by FML manufacturer, and is in meets the following requirements:
  - 1. Graded.
  - 2. Free of rocks larger than 2 inches, loam, organic matter, very soft clays, swelling clays, or fine uniform sands that may be difficult to compact
  - 3. ASTM D2487 Group Symbol: Any except those described as poorly graded and except CH, MH, OL, and OH.
  - 4. Minimum 70 percent passing the No. 200 sieve, minimum 20 percent clay content (<0.002 mm), and minimum plasticity index of 5.
  - 5. Maximum permeability of  $1 \times 10^{-5}$  cm/s determined in accordance with ASTM D5084.
  - 6. Compactable to specified density.

## 2.4 SOIL TYPE S3 (TOPSOIL)

- A. Friable loam neither heavy clay nor of very light sandy nature.
- B. Reasonably free of roots, rocks, or lumps larger than 2 inch, weeds, vegetation, and seeds of noxious weeds.
- C. Acidity Range (pH): 5.5 to 7.5.
- D. Containing minimum 4 percent and maximum 12 percent organic matter determined in accordance with ASTM D2974.

## 2.5 COARSE AGGREGATE

- A. Type A1 (Landfill Access Road Base, Culvert Pipe Envelope, and Drain Pipe Envelope): Size 57 DOT Kentucky Section 805.
- B. Type A2 (Geonet Daylighting): 2-inch clear crushed stone.

2.6 RIPRAP FOR STABILIZED CONSTRUCTION ENTRANCE AREA

- A. Unweathered, durable crushed or blasted igneous, metamorphic, or sedimentary rock.
- B. Free from organic, mica, shale, or other unsuitable material.
- C. Individual Rock Fragments: Hard, dense, sound, and resistant to abrasion and free of cracks, seams, and other structural defects that would tend to increase unduly their destruction by water and frost action and handling.
- D. Do not use rock exhibiting marked deterioration by water or weather.
- E. Bulk Specific Gravity of Rock Fragments: ASTM C127, minimum 2.6.
- F. Maximum aspect ratio (greatest to least dimension) of any piece of riprap shall not be greater than 2.5 when measured on mutually perpendicular axes.
- G. Gradation limits for riprap are in-place requirements. Make adjustment in production, transportation, and placement as necessary to ensure that placed materials are within specified range.

<i>Gradation</i>	<i>Maximum Percentage of Total Weight Smaller</i>
8 inches	100
6 inches	50
4 inches	15

- H. Well graded and not exhibiting gap grading or scalping from individual size ranges.
- I. Rock Quality:
  - 1. Absorption: ASTM C127, 2 percent maximum water absorption.
  - 2. Soundness: ASTM C88, 15 percent maximum at 5 cycles.
  - 3. Freeze-Thaw: ASTM C666, 12 percent maximum loss at 35 cycles.

2.7 SOURCE QUALITY CONTROL

- A. Section 01000 - General Requirements: Requirements for source testing and analysis of imported fill material.
- B. Testing and Analysis of Soil Type S1 and Type S2:
  - 1. Maximum Dry Density and Optimum Moisture Content, ASTM D698: 1 sample per 1,000 cu yd of material required.
  - 2. In-place Moisture Content, ASTM D2216: 1 sample per 500 cu yd of material required.
  - 3. Grain Size, ASTM D422: 1 sample per 500 cu yd of material required.

4. Atterberg Limits, ASTM D4318: 1 sample per 500 cu yd of material required.
5. Soil Classification, ASTM D2487: 1 sample per 1,000 cu yd of material required.
6. Hydraulic Conductivity, ASTM D5084: 1 sample per 1,000 cu yd of material required.
7. Chemical Analysis: 1 sample per 1,000 cu yd of material required. In accordance with Paragraph 2.7 E.

C. Testing and Analysis of Soil Type S3:

1. Soil Classification, ASTM D2487: 1 sample per 1,000 cu yd of topsoil required.
2. pH, ASTM D4972: 1 sample per 1,000 cu yd of topsoil required.
3. Organic Matter, ASTM D2974: 1 sample per 1,000 cu yd of topsoil required.
4. Phosphorus, potassium, calcium, and magnesium, in accordance with state accredited method: 1 sample per 1,000 cu yd of topsoil required.
5. Chemical Analysis: 1 sample per 1,000 cu yd of topsoil required. In accordance with Paragraph 2.7 E.

D. Testing and Analysis of Coarse Aggregate:

1. Grain Size, ASTM C117 and C136: 1 sample of each material required.
2. Chemical Analysis: 1 sample per source of each material. In accordance with Paragraph 2.7 E.

E. Chemical characterization in the laboratory in accordance with the following methods:

<i>Parameter</i>	<i>Extraction/Preparation<sup>(1)</sup></i>	<i>Analysis<sup>(1)</sup></i>
TCL <sup>(2)</sup> Volatile Organic Compound	5035	8260B
TCL Semi-Volatile Organic Compound	3540C/3550B	8270C
Pesticide	3540C/3550B	8081A
PCB	3540C/3550B	8082
Herbicides	3540C/3550B	8151A
<i>Parameter</i>	<i>Extraction/Preparation<sup>(1)</sup></i>	<i>Analysis<sup>(1)</sup></i>
TAL <sup>(3)</sup> Metals Series	3050B or 3051	6010B/7000
Cyanide	9013	9010 or 9012A

Notes:

- (1) USEPA SW-846.
  - (2) TCL - Target Compound List.
  - (3) TAL - Target Analyte List.
- F. If tests indicate materials do not meet specified requirements, change material or material source and retest.
- G. Provide materials of each type from the same source throughout the Works.
- H. In the event of changes to approved sources of materials during the performance of the Works, immediately advise CRA of revised locations and obtain approval of such locations and materials prior to use in the Works.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Section 01000 - General Requirements: Verification of existing conditions before starting work.
- B. Do not allow or cause any of the work performed or installed to be covered up or enclosed by work of this Section prior to required inspections, measurements, tests, or approvals.
- C. Obtain approval from CRA for completed excavations and previously placed material prior to placement of successive lifts.
- D. Obtain approval from CRA prior to placing fill against structures or around exposed buried utilities.
- E. Ensure areas to be backfilled are free from debris, snow, ice, water, soft soils, organic materials, or frozen ground.
- F. Do not place riprap over frozen or spongy subgrade surfaces.

#### 3.2 PREPARATION

- A. Remove debris, snow, ice, water, soft soils, organic materials, or frozen ground from areas to be backfilled.
- B. Compact subgrade to density requirements for subsequent backfill materials.
- C. Cut out soft areas of subgrade not capable of compaction in place. Backfill with Soil Type S1 fill and compact to density equal to or greater than requirements for subsequent fill material.
- D. Decontaminate equipment which has handled contaminated or potentially contaminated material at the decontamination area prior to being used for backfilling operations.

### 3.3 FILLING

- A. Fill areas to grades and elevations shown on the Drawings.
- B. Soil Type S1: Place and compact material in equal continuous layers not exceeding 6 inches compacted depth.
- C. Soil Type S2: Place and compact material in 1 layer not exceeding 4 inches compacted depth.
- D. Employ a placement method that does not disturb or damage other work.
- E. Maintain optimum moisture content of backfill materials to attain required compaction density.
- F. Make gradual grade changes. Blend slope into level areas.
- G. Leave backfill material stockpile areas free of excess materials.
- H. Do not operate heavy compaction equipment closer than 5 feet to underground utilities, or monitoring wells.
- I. Compact each layer to density specified in Article 3.5 before placing succeeding layers.

### 3.4 PLACING TOPSOIL

- A. Spread Soil Type S3 to settled depth of 6 inches over area to be seeded.
- B. Place Soil Type S3 during dry weather and on dry unfrozen subgrade.
- C. Remove vegetable matter and foreign non-organic material from Soil Type S3 while spreading.
- D. Grade Soil Type S3 to eliminate rough, low, or soft areas, and to ensure positive drainage.
- E. Rake until smooth, and then roll lightly.

### 3.5 COMPACTION

- A. Soil Type S1: Compact to 90 percent SMDD.
- B. Soil Type S2: Compact to 95 percent SMDD.
- C. Aggregate Type A1: Compact with four passes of 10-ton vibratory roller.
- D. Apply uncontaminated water as necessary during compaction to obtain specified density. If material to be compacted is excessively moist, aerate with suitable equipment and methods until the moisture content is corrected. In areas not accessible to rolling equipment, compact material to specified density with mechanical tampers.
- E. Do not direct jets of water at fill with such force that finer materials will be washed out.

- F. Compaction Equipment: The type, size, and efficiency of compaction equipment shall be capable of achieving specified degree of compaction. When operating equipment adjacent to and immediately above structures, exercise care so as not to cause damage or displacement of the structure.

### 3.6 STOCKPILING (IF REQUIRED)

- A. Stockpile materials on Site at locations on landfill designated by CRA. Obtain CRA's approval prior to placing material in such stockpiles.
- B. Stockpile in sufficient quantities to meet schedule and requirements.
- C. Construct stockpile sites so that they are level, well drained, free of foreign materials, and of adequate bearing capacity to support the weight of materials to be placed thereon.
- D. Provide and maintain access to stockpiles.
- E. Separate differing materials with substantial dividers or stockpile apart to prevent mixing.
- F. Prevent intermixing of soil types or contamination or segregation.
- G. Direct surface water away from stockpile sites to prevent erosion or deterioration of materials.
- H. Maintain temporary stockpile slopes not steeper than 2 horizontal to 1 vertical. In no instance shall stockpiles be greater than 15 feet in height above original surrounding grade. Place hay bales or soil erosion and sediment control fencing at the base of and around each temporary stockpile to contain soil that may be washed off the stockpile.
- I. Maintain area surrounding stockpiles in a neat and tidy condition.
- J. Cover stockpiled material with robust tarpaulin to withstand adverse weather, wind, and other detrimental forces. Provide total protection of stockpiled material from rain and other adverse weather effects.

### 3.7 STOCKPILE CLEANUP

- A. Remove stockpile, leave area in a clean and neat condition. Grade Site surface to prevent freestanding surface water.

### 3.8 TOLERANCES

- A. Top Surface of Backfilling: Plus or minus 1 inch from required elevations.
- B. Cap Layer Thickness: Plus or minus 1 inch from required thickness although not uniformly thicker or thinner.

### 3.9 FIELD QUALITY CONTROL

A. Section 01000 - General Requirements: Field inspection and testing.

B. Testing by CONTRACTOR:

1. Select samples of uncompacted fill intended for placement and samples of compacted fill.
2. Perform tests in the field and in the laboratory on samples of backfill and imported fill to determine if materials meet specification. Testing of imported fill will include analyses for the presence of contaminants, grain size analyses, moisture content determination, bulk wet density, maximum dry density, and hydraulic conductivity. Testing for backfill will include moisture content determination, maximum dry density, and bulk wet density. Cap layer thickness shall be measured in place.

C. Testing by CRA:

1. CRA may select samples of uncompacted fill intended for the placement and samples of compacted fill.
2. CRA may perform tests in the field and in the laboratory on samples of backfill and imported fill to determine if materials meet specification. Testing of imported fill may include analysis for the presence of contaminants, grain size analysis, moisture content determination, bulk wet density, maximum dry density, and hydraulic conductivity. Testing for backfill may include moisture content determination, maximum dry density, and bulk wet density. Copies of test reports will be supplied to CONTRACTOR on request.
3. Testing by CRA will in no way relieve CONTRACTOR of his responsibility to test all material prior to notifying CRA of materials' suitability for the work involved.

D. Methods of Testing:

1. Maximum dry density and optimum moisture content will be determined in the laboratory in accordance with ASTM D698.
2. Moisture content will be determined in the laboratory in accordance with ASTM D2216.
3. Bulk wet density will be determined in the field in accordance with ASTM D6938.
4. Moisture content will be determined in the field in accordance with ASTM D6938.
5. Particle size analysis will be performed in accordance with ASTM D422.
6. Hydraulic conductivity will be determined in accordance with ASTM D5084 on a representative sample compacted in the laboratory to the field bulk wet density and moisture.

E. Frequency of Testing:

1. Soil Type S1 and S2:

1. At least 1 in-place density and moisture for each lift for each 10,000 sq ft of area.

2. At least 1 maximum dry density and optimum moisture content for each change of material.
  3. One hydraulic conductivity will be made for each 4,000 cu yd of fill placed.
  4. At least 1 layer thickness measurement of each node point of a 100 by 100-foot grid over the landfill cap.
2. Aggregate Type A1 and A2: At least 1 particle size analysis.
- F. Failure to Meet Specified Requirements: If tests indicate that material specifications have not been achieved or cannot be obtained with equipment in use, procedure being followed, or material being incorporated, remove and replace work and modify operations so that the equipment, procedures, and materials will produce the required results. Additional testing required by CRA will be to CONTRACTOR's account.
- 3.10 ADJUSTING
- A. Finish compacted surfaces to within 1 inch of grades shown on the Drawings but not uniformly high or low. Correct surface irregularities by loosening and adding or removing material until the surface is within specified grade.
  - B. Leave work areas in a properly graded condition sloped as required to permit proper drainage and free of depressions that will pond or collect water or debris that will restrict flow.
- 3.11 CLEANING
- A. Clean and reinstate work areas and areas affected by equipment outside areas specified to be excavated, to specified restoration condition.
  - B. Upon completion of backfilling, remove excess material and debris from work areas and travel routes.
- 3.12 PROTECTION OF FINISHED WORK
- A. Reshape and recompact fills subjected to vehicular traffic.

END OF SECTION

## SECTION 02317

### EXCAVATION

#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES

- A. Excavating contaminated soil.

##### 1.2 DEFINITIONS

- A. Excavation: Removal of materials of whatever nature encountered, whether wet, frozen, or otherwise, including dense tills, hardpan, frozen materials, cemented materials, concrete fragments, asphalt pavement, boulders or rock fragments, and weathered rock which can be removed by ripping or excavating with heavy-duty mechanical construction equipment without drilling and blasting.
- B. Excavation Limits: Areal excavation limits shown on the Drawings to specified depth or as directed by CRA and does not include areas shown as being on hold pending further sampling and analysis by CRA.
- C. Rock: Material from solid masses of igneous, sedimentary, or metamorphic rock which, prior to its removal, was integral with its parent mass, and boulders or rock fragments having individual volume in excess of 1 cu yd.

##### 1.3 PROGRESS SUBMITTALS

- A. Section 01000 - General Requirements: Requirements for progress submittals.
- B. Excavation Plan: Prior to mobilization to the Site, submit a detailed Excavation Plan demonstrating compliance with specified requirements and to permit CRA to schedule testing and measurement activities. Include written procedures, schedules, and drawings as applicable and, at a minimum, address each of the following items:
  - 1. Methods and procedures which will be used to perform excavation.
  - 2. Sequencing and scheduling of excavation and backfilling in excavation areas.
  - 3. Locations and sequencing of constructed and relocated temporary decontamination facilities.
  - 4. Sequencing and layout of access routes to and from excavation areas.
  - 5. Sequencing and scheduling of placement of impacted soil in designated areas.

#### 1.4 ENVIRONMENTAL REQUIREMENTS

- A. Section 01000 - General Requirements: Requirements for temporary controls.
- B. Protect open excavations against damage due to surface runoff and runoff. Take necessary precautions to prevent erosion of excavated or disturbed surfaces.
- C. Suspend operations whenever climatic conditions, as determined by CRA, may detrimentally affect the quality of excavated material and prevent their use as backfill.
- D. After occurrence of heavy rains, do not operate equipment on approved excavations until the material has dried sufficiently to prevent occurrence of excessive rutting.
- E. Where excavations have been softened or eroded, remove soft and yielding material or otherwise objectionable or damaged areas and replace with fill as specified by CRA, at no additional cost to OWNER.
- F. Decontaminate equipment involved in excavation activities that may have come in contact with potentially contaminated material before being removed from the Site or being relocated to clean areas of the Site.

#### 1.5 SEQUENCING AND SCHEDULING

- A. Section 01000 - General Requirements: Requirements for coordination.
- B. Sequence and schedule excavation activities with work of other Sections.
- C. Do not commence excavation operations until the Site-specific Health and Safety Plan has been reviewed by CRA and implemented and decontamination facilities and stockpiling facilities are constructed and operational.
- D. Coordinate and sequence excavation operations to minimize the need for temporary stockpiling of excavated materials.
- E. Do not allow or cause any of work to be covered up or enclosed prior to required inspections, tests, or approvals.

### PART 2 PRODUCTS (NOT USED)

### PART 3 EXECUTION

#### 3.1 PREPARATION

- A. Identify required lines, levels, contours, and datum locations.
- B. Locate, identify, and protect utilities from damage. Confirm locations of buried utilities and structures including piping related to SVE and groundwater remedial systems by careful test excavations or other suitable means.

- C. Arrange for utility company to identify and relocate utilities.
- D. Protect plant life, lawns, and other features remaining as a portion of final landscaping.
- E. Maintain and protect from damage bench marks and survey control points, wells, utilities, surface features, and structures encountered, and not designated for removal. In the event of disturbance of or damage to any such well, utility, surface features, or structures, immediately notify CRA. Repair or replace, as directed by CRA, any well, utility, surface feature, or structure damaged by CONTRACTOR operations unless specified for removal.
- F. Protect existing buildings, wells, facilities, surface features, and structures where temporary unbalanced earth pressures or uplift are liable to develop utilizing bracing, shoring, or other approved methods to counteract unbalance.
- G. Employ procedures for excavation/trenching such that disturbance of wells, utilities, surface features, and structures is avoided.
- H. Protect excavations/trenches from contamination and water runoff.
- I. Obtain direction from CRA before moving or otherwise disturbing wells, utilities, surface features, and structures.

### 3.2 EXCAVATING - GENERAL

- A. Excavate to lines, grades, elevations, and dimensions shown on the Drawings or as directed by CRA.
- B. Notify CRA of unexpected subsurface conditions and discontinue affected work in area until notified to resume work.
- C. Hand trim, make firm, and remove loose material and debris from excavations. Where natural or fill material at bottom of excavation, except excavation for foundations, is disturbed, compact disturbed soil to density at least equal to undisturbed soil or to the density specified for the succeeding layer of backfill, whichever is greater, or remove disturbed soil and refill the space as directed by CRA.
- D. Do not disturb soil within the branch spread of trees or shrubs that are to remain. If excavating through roots, excavate by hand and cut roots with sharp axe or saw. Seal cuts with approved tree wound dressing.
- E. Open excavations shall be CONTRACTOR's sole responsibility.
- F. Stockpile clean soil in area designated on the Site for later use as backfill material.

### 3.3 OVER-EXCAVATING

- A. Notify CRA when soil at the bottom of the excavation appears unsuitable and proceed as directed by CRA. Where, in CRA's opinion, the undisturbed condition of the soils is inadequate for the support of installations, over-excavate to adequate supporting soils as directed by CRA and refill

the excavated space with approved material to the proper elevation in accordance with the procedure specified for backfill.

- B. Backfill in accordance with Section 02316.
- C. Should unauthorized excavation be carried below the lines and grades shown on the Drawings and in excess of specified limits and tolerance because of CONTRACTOR's operations including errors, methods of construction, or to suit his convenience, correct unauthorized excavation as follows: Fill under unauthorized over-excavation areas by extending the indicated bottom elevation of the base of the material specified to be placed to the unauthorized excavation bottom without altering the required top elevation and compact in accordance with Section 02316 unless otherwise directed by CRA.
- D. Additional excavation to remove weakened or disturbed soil or any additional activity caused by CONTRACTOR's error, unsuitable construction methods or procedures, or to suit CONTRACTOR's convenience and subsequent additional backfill and compaction to correct deficiencies shall be at no additional cost to OWNER.

#### 3.4 PROTECTING CLEAN SOIL FROM CONTAMINATION

- A. Prevent contamination of adjacent clean soil.
- B. Place plastic sheeting and plywood under excavation equipment and alongside the excavation to prevent contaminated soil from being mixed with surrounding clean soil. Use other means of preventing contamination subject to approval by CRA. Do not mix excavated soil with imported materials.
- C. Load contaminated soil directly into transport vehicles/containers for on-Site disposal.
- D. Decontaminate excavation equipment after handling contaminated materials and prior to handling clean overburden. CRA will direct additional decontamination as necessary in the opinion of CRA.

#### 3.5 EXCAVATING CONTAMINATED SOIL

- A. Excavate soil to depths and dimensions as shown on the Drawings and as directed by CRA.
- B. Whenever possible, load contaminated excavated soil directly into haulage units licensed to carry contaminated soils. Perform loading to minimize contamination of the exterior of haulage units and the loading area. Consolidate waste material excavated in areas to be covered with landfill cap and compact in accordance with subgrade compaction requirements.
- C. Perform excavation in such a manner that only the excavation bucket and boom contacts contaminated soil.
- D. Upon completion of excavation CRA will obtain confirmatory soil samples from the base of the excavation.
- E. Keep limits of excavation undisturbed and free of loose, soft, or organic matter.

- F. Where directed by CRA, stage moist or wet material in a temporary stockpile on the landfill and allow to drain prior to backfilling.
- G. Maintain excavation depth tolerances. Unless directed by CRA, excavation in excess of specified limits shall be considered unauthorized over-excavation.
- H. Should unauthorized excavation be carried below the lines and grades shown on the Drawings and in excess of specified limits and tolerance because of CONTRACTOR's operations including errors, methods of construction, or to suit his convenience, correct unauthorized excavation as described in Article 3.3.
- I. Keep excavations open until directed to be backfilled by CRA. For the duration of an open excavation, maintain the excavation free from water and adequately mark the open excavation with temporary fencing to restrict access until the excavation is properly backfilled.
- J. Schedule excavation activities in such a manner that access is available to any excavation area for additional excavation as directed by CRA. In returning to an area for additional excavation, comply with previously specified access route restrictions.
- K. Decontaminate excavation equipment periodically and as directed by CRA. Decontaminate equipment when visibly contaminated or when moving from a significantly contaminated area to one of lesser contamination for excavation work. Decontaminate equipment prior to performing additional excavation in an excavation previously left open pending sampling and analysis by CRA. CRA will direct additional decontamination when required in the opinion of CRA.

### 3.6 TOLERANCES

- A. General: Within 2 inches greater or less than specified depth but not uniform greater or less.

### 3.7 CLEANING

- A. Section 01700 - Execution Requirements: Requirements for cleaning installed work.
- B. Clean and reinstate work areas and areas affected by equipment outside areas specified to be excavated, to specified restoration condition.

### 3.8 PROTECTION OF FINISHED WORK

- A. Section 01700 - Execution Requirements: Requirements for protecting installed work.
- B. Protect bottom of excavations from freezing and disturbance.

END OF SECTION



## SECTION 02610

### PIPE CULVERTS

#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES

- A. Pipe culvert, joints, and accessories.
- B. Sub-drain pipe

##### 1.2 REFERENCES

- A. Section 01000 - General Requirements: Requirements for references.
- B. American Association of State Highway and Transportation Officials (AASHTO): M294 - Specification for Corrugated Polyethylene Drainage Tubing, 12 to 48 Inch Diameter.
- C. State of Kentucky Transportation Cabinet Standard Specifications for Road and Bridge Construction.

##### 1.3 DEFINITIONS

- A. Bedding: Fill placed under, beside, and directly over pipe, prior to subsequent backfill operations.
- B. HDPE: High Density Polyethylene.
- C. 'State Standard' in this Section shall mean State of Kentucky Transportation Cabinet Standard Specifications for Road and Bridge Construction.

##### 1.4 PROGRESS SUBMITTALS

- A. Section 01000 - General Requirements: Requirements for progress submittals.
- B. Product Data: Include pipe materials, pipe fittings, and accessories.
- C. Manufacturer's Instructions: Include installation instructions and pipe jointing methods.

##### 1.5 CLOSEOUT SUBMITTALS

- A. Section 01000 - General Requirements: Requirements for closeout submittals.
- B. Record Documents: Indicate actual locations of piping, connections, and invert elevations; identify and describe unexpected variations to subsoil conditions.

## 1.6 QUALITY ASSURANCE

- A. Perform work of this Section in accordance with State Standard.

## 1.7 DELIVERY, STORAGE, AND HANDLING

- A. Section 01000 - General Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Deliver, store, and handle pipe in accordance with applicable requirements of specified references, manufacturer's instructions, and as specified herein.
- C. Use every precaution to prevent damage to pipe. Do not permit metal tools or heavy objects to unnecessarily come in contact with pipe. Repair damage to pipe from any cause during installation as directed by CRA.

## 1.8 SEQUENCING AND SCHEDULING

- A. Section 01000 - General Requirements: Requirements for coordination.
- B. Schedule work to minimize time during which trenches and excavations remain open.

## PART 2 PRODUCTS

### 2.1 CULVERT

- A. Pipe: HDPE, corrugated smooth wall inside, AASHTO M294 Type S, 18 inch diameter.
- B. Fittings and Joints: AASHTO M294.

### 2.2 SUB-DRAIN PIPE

- A. Pipe: HDPE corrugated tubing heavy duty AASHTO M252, minimum pipe stiffness of 35 psi at 5 percent deflection, perforated Type CP, slot width 1/16 inch, 4 slots per valley spaced 90 degrees apart, rotated 45 degrees every other valley, 4 inch diameter.
- B. Fittings and Joints: AASHTO M294.

### 2.3 ACCESSORIES

- A. Bedding: Section 02316, Aggregate Type A1.
- B. Geotextile: Section 02074.

## 2.4 SOURCE QUALITY CONTROL

- A. Section 01000 - General Requirements: Requirements for source testing.
- B. Manufacturer Quality Control: Comply with AASHTO M294.

## PART 3 EXECUTION

### 3.1 EXAMINATION

- A. Section 01000 - General Requirements: Verification of existing conditions before starting work.
- B. Obtain approval from CRA for completed excavation prior to placing bedding material or piping, if conventional excavation method is used.
- C. Verify trench line and grade.

### 3.2 PREPARATION

- A. Remove scale and dirt on inside and outside of piping before assembly.
- B. Carefully inspect materials for defects and promptly remove defective materials from Site.
- C. Clean pipe of accumulated debris and water before installation.
- D. Remove large stones or other hard matter which could damage piping or impede consistent backfilling or compaction.

### 3.3 INSTALLATION

- A. Excavate pipe trench in accordance with Section 02317, hand trim excavation for accurate placement of pipe to elevations shown on the Drawings.
- B. Bedding:
  - 1. Shape bed true to line and grade to provide continuous uniform bearing surface for pipe exterior. Do not use blocks when bedding pipe.
  - 2. Place bedding at trench bottom in 1 continuous layer not exceeding 6 inches compacted depth, level, and compact in accordance with Section 02316.
  - 3. Maintain optimum moisture content of bedding to attain required compaction density.
- C. Pipe:
  - 1. Install pipe and accessories in accordance with manufacturer's instructions.
  - 2. Install pipe to elevation shown on the Drawings to within a tolerance of 1/4 inch.

3. Route pipe in straight line.
  4. Lift or roll pipe into position. Do not drop or drag pipe over prepared bedding.
  5. Do not lay pipe on frozen bedding, in water, or when trench conditions are unsuitable.
- D. Place aggregate cover at sides of pipe, tamp in place, and compact in accordance with Section 02316.

END OF SECTION

## SECTION 02821

### CHAIN LINK FENCES AND GATES

#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES

- A. Fence framework, fabric, and accessories.
- B. Excavation for post bases, concrete foundation for posts, and center drop for gates.
- C. Manual gates and related hardware.

##### 1.2 REFERENCES

- A. Section 01000 - General Requirements: Requirements for references.
- B. ASTM International (ASTM):
  - 1. A153/A153M - Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
  - 2. A239 - Standard Practice for Locating the Thinnest Spot in a Zinc (Galvanized) Coating on Iron or Steel Articles.
  - 3. A392 - Standard Specification for Zinc-Coated Steel Chain-Link Fence Fabric.
  - 4. A780 - Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
  - 5. C94 - Standard Specification for Ready-Mixed Concrete.
  - 6. F567 - Standard Practice for Installation of Chain-Link Fence.
  - 7. F626 - Standard Specification for Fence Fittings.
  - 8. F669 - Standard Specification for Strength Requirements of Metal Posts and Rails for Industrial Chain Link Fence.
  - 9. F900 - Standard Specification for Industrial and Commercial Swing Gates.
  - 10. F1083 - Standard Specification for Pipe, Steel, Hot-Dipped Zinc-Coated (Galvanized) Welded, for Fence Structures.
  - 11. F1234 - Standard Specification for Protective Coatings on Steel Framework for Fences.
- C. Chain Link Fence Manufacturers Institute (CLFMI): Product Manual.

### 1.3 DEFINITIONS

- A. Fence Post: An upright tubular or fabricated steel member for supporting fencing material.
- B. Line Posts: Fence posts spaced at regular intervals between terminal posts throughout each stretch of fence.
- C. Terminal Posts: Fence posts which include end, gate, corner, and straining posts.
- D. End Posts: Fence posts positioned at the ends of a stretch of fence.
- E. Gate Posts: 2 fence posts forming a gateway.
- F. Corner Posts: Fence posts positioned at corners and changes of direction greater than 10 degrees.
- G. Straining Posts: Fence posts positioned at changes in grade greater than 30 degrees.
- H. Top Rail: Tubular or fabricated steel section continuously joined by means of sleeves or couplings throughout each stretch of fence extending between terminal posts.
- I. Brace Rail: Tubular or fabricated steel section used for bracing terminal posts.
- J. Diagonal Brace Wire: Wire used for bracing terminal posts.
- K. Top Wire: Wire installed at top of fence and extending throughout each stretch of fence between terminal posts.
- L. Bottom Wire: Wire installed at bottom of fence and extending throughout each stretch of fence between terminal posts.
- M. Fittings: Mechanical connections of various designs, shapes, and metals to join fence components into an integral structure.
- N. Wire Ties: Wire used to tie chain link fence fabric to line posts, bottom wires, and top rails or top wires.
- O. Knuckled: Type of selvage obtained by interlocking adjacent wire ends, in pairs, and then bending the wire ends back into a closed loop.
- P. Non-shrink Cement Grout: A bedding compound that is inert and free from shrinkage.

### 1.4 SYSTEM DESCRIPTION

- A. Fence Height: 7 feet nominal as shown on the Drawings.
- B. Line Post Spacing: At intervals not exceeding 10 feet.
- C. Fence Post and Rail Strength: Conform to ASTM F669, Light industrial fence, Group 1A.

## 1.5 PROGRESS SUBMITTALS

- A. Section 01000 - General Requirements: Requirements for progress submittals.
- B. Shop Drawings: Indicate plan layout, spacing of components, post foundation dimensions, hardware anchorage, and schedule of components.
- C. Product Data: Submit 21 days prior to installation. Include for fabric, posts, accessories, fittings, and hardware.
- D. Samples: Submit 21 days prior to installation. Submit sample of mesh.
- E. Manufacturer's Instructions: Indicate installation requirements, post foundation anchor bolt templates.

## 1.6 CLOSEOUT SUBMITTALS

- A. Section 01000 - General Requirements: Requirements for closeout submittals.
- B. Record Documents: Accurately record actual locations of property perimeter posts relative to property lines.

## 1.7 QUALITY ASSURANCE

- A. Perform work of this Section in accordance with ASTM F567.

## 1.8 QUALIFICATIONS

- A. Manufacturer: Company specializing in manufacturing the products specified in this Section with minimum 3 years documented experience.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01000 - General Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Deliver chain link fence fabric in firmly tied tight rolls.
- C. Tag each roll clearly indicating class of coating, specified wire size, mesh size, height of fabric, ASTM A392 designation, and manufacturer's name.
- D. Store and handle materials in accordance with manufacturer's instructions. In the event of damage, make repairs or replacements approved by ENGINEER.
- E. Protect zinc and PVC-coated surfaces from damage and protect fencing materials from distortion or bending.
- F. Repair damaged zinc-coated surfaces as specified.

## 1.10 SEQUENCING AND SCHEDULING

- A. Section 01000 - General Requirements: Requirements for coordination.
- B. Do not commence fence installation until installation of 12-inch soil cover is complete and prior to installation of topsoil along fence alignment.

## PART 2 PRODUCTS

### 2.1 MATERIALS

- A. Framing: ASTM F1083 Schedule 40, galvanized steel pipe, welded construction, minimum yield strength of 25 ksi; coating conforming to ASTM A239 on pipe exterior and interior.
- B. Fabric: ASTM A392, Zinc coated wire diameter 0.148 inch, mesh size 2 inches.
- C. Fittings: ASTM F626.
- D. Gates: ASTM F900, Steel, consistent with fence framing.
- E. Concrete: ASTM C94, Normal Portland cement, 2,500 psi strength at 28 days.

### 2.2 COMPONENTS

- A. Line Posts: 2 1/2 inch diameter.
- B. Corner and Terminal Posts: 3 inch.
- C. Gate Posts: 8 inch diameter.
- D. Top and Brace Rail: 1 5/8 inch diameter, plain end, sleeve coupled.
- E. Gate Frame: 2 inch diameter for fittings and truss rod fabrication.
- F. Fabric: 2 inch diamond mesh interwoven wire, 9 gage, top salvage knuckle end closed, twisted tight, bottom selvage twisted tight and knuckle end closed.
- G. Tension Wire: 6 gage steel, single strand.
- H. Tension Band: 0.188-inch thick steel.
- I. Tension Strap: 0.188-inch thick steel.
- J. Tie Wire: Aluminum alloy steel wire.

## 2.3 ACCESSORIES

- A. Caps: Cast steel galvanized; sized to post diameter, set screw retainer.
- B. Fittings: Sleeves, bands, clips, rail ends, tension bars, fasteners and fittings; steel.
- C. Extension Arms: Cast steel galvanized, to accommodate 3 strands of barbed wire, single arm, sloped to 45 degrees.
- D. Gate Hardware: Fork latch with gravity drop; two 180-degree gate hinges per leaf and hardware for padlock.

## 2.4 FINISHING

- A. Components and Fabric: Galvanized, 1.2 ounces per sq ft coating.
- B. Hardware: Galvanized in accordance with ASTM A153/A153M, 1.8 ounces per sq ft coating.
- C. Accessories: Same finish as fabric.

# PART 3 EXECUTION

## 3.1 EXAMINATION

- A. Section 01000 - General Requirements: Verification of existing conditions before starting work.
- B. Verify that surfaces and the Site conditions are ready to receive work.

## 3.2 PREPARATION

- A. Remove debris and correct ground undulations along fence lines to obtain a smooth uniform gradient between posts.
- B. Do not reuse existing fence materials designated for on-Site disposal.
- C. Maintain security of Site during removal of existing fences and installation of new fence and gate.

## 3.3 INSTALLATION

- A. Install framework, fabric, and accessories, and gates in accordance with ASTM F567 and manufacturer's instructions.
- B. Place fabric on outside of posts and rails.
- C. Set intermediate, terminal, gate, and posts plumb, in concrete footings with top of footing 2 inches above finish grade. Slope top of concrete for water runoff.
- D. Line Post Footing Depth Below Finish Grade: As shown on Drawings.

- E. Corner, Gate, and Terminal Post Footing Depth Below Finish Grade: As shown on Drawings.
- F. Brace each gate and corner post to adjacent line post with horizontal center brace rail and diagonal truss rods. Install brace rail 1 bay from end and gate posts.
- G. Provide top rail through line post tops and splice with 6-inch long rail sleeves.
- H. Install center and bottom brace rail on corner gate leaves.
- I. Do not stretch fabric until concrete foundation has achieved a minimum of 2,000 psi compressive strength or has been cured for a minimum of 5 days.
- J. Stretch fabric between terminal posts or at intervals of 100 feet maximum, whichever is less.
- K. Position bottom of fabric 2 inches above finished grade.
- L. Fasten fabric to top rail, line posts, braces, and bottom tension wire with tie wire at maximum 15 inches on centers.
- M. Attach fabric to end, corner, and gate posts with tension bars and tension bar clips.
- N. Install bottom tension wire stretched taut between terminal posts.
- O. Do not attach hinged side of gate from building wall; provide gate posts on both sides of gate openings.
- P. Install gate with fabric to match fence.
- Q. Provide concrete center drop to footing depth and drop rod retainers at center of double gate openings.
- R. Install corner posts where change in alignment exceeds 20 degrees horizontally.

### 3.4 TOLERANCES

- A. Maximum Variation from Plumb: 1/2 inch.
- B. Maximum Offset from True Position: 2 inch.
- C. Components shall not infringe adjacent property lines.

### 3.5 FIELD QUALITY CONTROL

- A. Section 01000 - General Requirements: Field inspection and testing.
- B. Repair damaged galvanized surfaces in accordance with ASTM A780.
- C. Apply field repair coating to damaged galvanized surfaces at dry film thickness at least equal to specified galvanized coating thicknesses.

### 3.6 CLEANING

- A. Spread soil excavated from post holes uniformly on ground surface, on the inside of proposed fence alignment, or utilize to backfill post holes along existing fence alignments.

END OF SECTION



## SECTION 02921

### HYDROSEEDING

#### PART 1 GENERAL

##### 1.1 SECTION INCLUDES

- A. Placing topsoil.
- B. Hydroseeding.
- C. Dormant seeding, if required.
- D. Installation of erosion control blanket.
- E. Maintenance for seed establishment.
- F. Installation of turf reinforcement matting.

##### 1.2 REFERENCES

- A. Section 01000 - General Requirements: Requirements for references.
- B. Official Seed Analysis of North America.
- C. State of Kentucky Transportation Cabinet Standard Specifications for Road and Bridge Construction.

##### 1.3 DEFINITIONS

- A. Weeds: Include, but are not limited to, Dandelion, Jimsonweed, Quackgrass, Horsetail, Morning Glory, Rush Grass, Mustard, Lambsquarter, Chickweed, Cress, Crabgrass, Canadian Thistle, Nutgrass, Poison Oak, Blackberry, Tansy Ragwort, Bermuda Grass, Johnson Grass, Poison Ivy, Nut Sedge, Nimble Will, Bindweed, Bent Grass, Wild Garlic, Perennial Sorrel, and Brome Grass.
- B. Noxious Weeds:
  - 1. Harmful, undesirable, hard to control.
  - 2. Include but are not limited to: Johnson Grass or Johnson Grass Crosses, Canadian Thistle, Quackgrass, Wild Garlic and Wild Onion, Bermuda Grass, Annual Blue Grass, Corn Cockle, Dodder, and Blindweed.
- C. 'State Standard' in this Section shall mean State of Kentucky Transportation Cabinet Standard Specifications for Road and Bridge Construction.

#### 1.4 PROGRESS SUBMITTALS

- A. Section 01000 - General Requirements: Requirements for progress submittals.
- B. Seeding and Erosion Control Plan: At least 14 days prior to placing topsoil, submit to ENGINEER for approval CONTRACTOR's Seeding and Erosion Control Plan including, but not limited to, the following:
  - 1. Seed mixture(s) and fertilizers for the Site and adjacent areas and application rates.
  - 2. Time of year for planting such mixtures.
  - 3. Methods of preparing seedbed, seeding, and rolling seeded areas.
  - 4. Methods to provide erosion control until seed is placed and grass is established (i.e., use of any or a combination of emulsifiers, tackifiers, mulches, adhesives, and nurse crop seed).
- C. Seed Certificates: At least 14 days prior to seeding submit certificates from seed vendors for each seed mixture required, stating botanical and common name, percentage by weight and percentages of purity, germination, and weed seed for each species.
- D. Fertilizer Certificate: At least 14 days prior to placing fertilizer, submit certificate confirming conformance with recommendations provided by laboratory based on topsoil analysis.
- E. Erosion Control Blanket: At least 14 days prior to delivering erosion control blanket, submit manufacturer product data and delivery, handling, storage, installation, and repair methods.
- F. Test Results: At least 14 days prior to commencing transport to the Site, submit test results of imported topsoil. Indicate, by test results, information necessary to determine suitability, including, but not limited to, organic content, pH, phosphorus, potassium, calcium, and magnesium; and laboratory or supplier recommendation for fertilizer application rate for specified seed mixture.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Section 01000 - General Requirements: Requirements for closeout submittals.
- B. Maintenance Data: Include maintenance instructions, cutting method, and maximum grass height; types, application frequency, and recommended coverage of fertilizer.

#### 1.6 QUALITY ASSURANCE

- A. Perform work of this Section in accordance with the State Standards.
- B. Provide seed mixture in weatherproof containers showing percentage of seed mix, year of production, net weight, date of packaging, and location of packaging.

## 1.7 QUALIFICATIONS

- A. Seed Producer: Established vendor capable of providing adequate seed quality and quantities.
- B. Fertilizer: Established vendor capable of providing adequate fertilizer quality and quantities.
- C. Installer: Company specializing in planting and establishment of multiple acre grading and planting projects with 5 years documented experience.

## 1.8 REGULATORY REQUIREMENTS

- A. Comply with regulatory agencies for fertilizer and herbicide composition.
- B. Provide certificate of compliance from authority having jurisdiction indicating approval of seed mixture.

## 1.9 DELIVERY, STORAGE, AND HANDLING

- A. Section 01000 - General Requirements: Requirements for transporting, handling, storing, and protecting products.
- B. Deliver grass seed mixture in original sealed containers bearing seed Supplier's label and certificate indicating the content of species, grade, and mass. Seed in damaged packaging will be rejected. Label containers showing:
  - 1. Analysis of seed mixture.
  - 2. Percentage of pure seed.
  - 3. Percentage of weeds.
  - 4. Year of production.
  - 5. Net weight.
  - 6. Date when tagged and location.
  - 7. Percentage germination.
  - 8. Name and address of distributor.
- C. Deliver fertilizer in waterproof bags showing weight, chemical analysis, and name of manufacturer.
- D. Deliver mulch and erosion control agent in moisture-proof containers showing manufacturer, content, and net weight (air dry).
- E. Deliver erosion control blankets in a rolled mat form protected with an outer waterproof wrap bearing manufacturer's label indicating product name.

- F. Store materials in accordance with manufacturer's instructions and in a manner to prevent damage or deterioration.
- G. Remove from the Site seed which has become wet, moldy, or otherwise damaged in transit or storage.
- H. Store seed in weatherproof enclosures.

#### 1.10 ENVIRONMENTAL REQUIREMENTS

- A. Section 01000 - General Requirements: Requirements for temporary controls.
- B. Do not apply materials over snow, ice, frozen ground, or standing water.
- C. Do not apply seed slurry when wind conditions are such that material would be carried beyond designated area or that materials would not be uniformly applied or when wind velocity exceeds 5 miles per hour.

#### 1.11 SEQUENCING AND SCHEDULING

- A. Section 01000 - General Requirements: Requirements for coordination.
- B. Schedule topsoil placing to permit seeding operations under optimum conditions during normal planting seasons.
- C. Coordinate planting with specified maintenance periods to provide maintenance until acceptance by ENGINEER.
- D. Seed areas within 10 days of completion of topsoiling.
- E. Apply fertilizer at least 1 week after application of lime, if required.

### PART 2 PRODUCTS

#### 2.1 SEED MIXTURE

- A. Seed: The latest season's crop. Weed seed content not to exceed 1 percent by weight. Complying with the tolerance for purity and germination established by Official Seed Analysis of North America. Germination to exceed 75 percent. Remove any seed that is wet, moldy, unlabeled, or otherwise damaged.
- B. Acceptable seed mixes/blends and seeding rate in accordance with State Standard. Base seeding rates on pure live seed as follows:

$$\text{Minimum actual seeding rate} = \frac{\text{specified seeding rate}}{(\% \text{purity}/100) \times (\% \text{germination}/100)}$$

## 2.2 TOPSOIL

- A. Conform to Section 02316.

## 2.3 MULCHING MATERIAL

- A. Free of weeds and other foreign materials, free of growth or germination inhibiting ingredients; manufactured in such a manner that after addition and agitation in slurry tanks with water, the fibers in the material will become uniformly suspended to form a homogeneous slurry; dyed a suitable color to facilitate inspection of the placement of the material. When applied, capable of forming an absorptive mat, which will allow moisture to percolate into the underlying soil.

## 2.4 FERTILIZER

- A. Granular form, dry, free flowing, and free from lumps.
- B. Recommended for grass, with 50 percent of the elements derived from organic sources; of proportion necessary to eliminate any deficiencies of topsoil as indicated in analysis specified in Paragraph 1.4 E.

## 2.5 WATER

- A. Clean, fresh, and free of any contaminants and substances or matter which could inhibit germination and vigorous growth of grass.

## 2.6 EROSION CONTROL BLANKET

- A. C125 BN, North American Green.

## 2.7 TURF REINFORCEMENT MATTING

- A. Landlok TRM 450.

## 2.8 ACCESSORIES

- A. Lime (if required based on topsoil analysis): Ground agricultural limestone, minimum 85 percent of total carbonates graded as follows:

<i>Percent Passing By Weight</i>	<i>Sieve Size</i>
90	No. 18
50	No. 120

- B. Stakes: Softwood lumber, chisel pointed.

- C. Erosion Control Blanket Staples: U-shaped and constructed of wire with a diameter of at least 0.1 inch with legs at least 6 inches long and 1 inch apart.
- D. Erosion Control Agent:
  - 1. RESYN® 5792 polyvinyl acetate.
  - 2. The dried film after application shall conform to the following requirements:
    - 1. Solids: 55 percent.
    - 2. Viscosity: 2,000 to 10,000 centipoises.
    - 3. pH: 4 to 5.
    - 4. Specific Gravity: 1.04.
    - 5. Particle Size: 0.5 to 3 microns.
    - 6. pH: Less than 4.
    - 7. Freeze-Thaw Stability: To minus 5 degrees C.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Section 01000 - General Requirements: Verification of existing conditions before starting work.
- B. Verify that prepared soil base is ready to receive work of this Section.

#### 3.2 PLACING TOPSOIL

- A. Place and grade topsoil in accordance with Section 02316.
- B. Obtain ENGINEER's approval of topsoil grade and depth before starting seeding.

#### 3.3 HYDROSEEDING

- A. Seeding and mulching shall be a 1-step process in which seed, fertilizer, hydraulic mulch, and mulch adhesive are applied simultaneously in a water slurry via hydraulic seeder/mulcher.
- B. Apply seed at a rate as specified in State Standard.
- C. Hydraulic Seeder/Mulcher: Apply seed, fertilizer, hydraulic mulch, and temporary cover adhesive using an acceptable hydraulic seeder/mulcher. The hydraulic seeder/mulcher shall be equipped with mechanical agitation equipment capable of mixing the materials into a homogeneous slurry and maintaining the slurry in a homogeneous state until it is applied. The discharge pumps and gun nozzles shall be capable of applying the materials uniformly.

- D. Volume Certification: Hydraulic seeding/mulching equipment shall have the tank volume certified by a plate affixed by manufacturer and confirmed to ENGINEER by means of measurements or tests prior to the commencement work. This plate shall be affixed in plain view on the hydraulic seeder/mulcher and shall not be removed or altered. The plate shall certify tank volume only, and shall imply equipment conformance to other requirements of this Section.
- E. Application of Materials: Measure the quantity of each material to be charged into the hydraulic seeder/mulcher tank either by mass or by a system of mass-calibrated volume measurements acceptable to ENGINEER. Add the materials to the tank while it is being loaded with water. Thoroughly mix the materials into a homogeneous water slurry and distribute uniformly over the designated surface area via the hydraulic seeder/mulcher. Apply seed, fertilizer, and where applicable, hydraulic mulch adhesive within 2 hours of being charged into the hydraulic seeder/mulcher tank. During loading of the hydraulic seeder/mulcher tank, add materials in the following sequence: seed, then fertilizer, then, where applicable, hydraulic mulch and adhesive.
- F. Blend into existing adjacent grass areas to bond new growth to existing adjacent areas or to previous applications to form uniform surfaces.

#### 3.4 DORMANT SEEDING, IF REQUIRED

- A. The following methods may be used for dormant seeding:
  - 1. From November 1 through February 28, when soil conditions allow, prepare the seedbed, apply lime and fertilizer, apply the selected seed mixture, mulch, and erosion protection. Increase the seeding rates by 50 percent.
  - 2. Apply seed uniformly with a cyclone seeder, drill, cultipacker seeder, or hydroseeder (slurry may include seed and fertilizer) on a firm, moist seedbed. For drill seeding, uniformly drill seed to a depth of 1/2- to 3/4-inch using equipment having drills not more than 6 1/2 inches apart. Use row markers with the drill seeder. Do not reroll areas seeded with seed drills equipped with rollers.
  - 3. Where feasible, except when a cultipacker type seeder is used, the seedbed shall be firmed following seeding operations with a cultipacker, roller, or light drag. On sloping land, seeding operations shall be on the contour where feasible.

#### 3.5 EROSION CONTROL BLANKETS AND TURF REINFORCEMENT MATTING

- A. Identify seeded areas with stakes and string around area periphery.
- B. Install erosion control blankets and turf reinforcement matting, and anchor in accordance with manufacturer's instructions.
- C. Lay blankets and matting smoothly on surface, bury top end of each section in 6-inch deep excavated topsoil trench. Provide 12-inch overlap of adjacent rolls and staple. Backfill trench and rake smooth, level with adjacent soil.
- D. Secure outside edges and overlaps at 36-inch intervals with stakes.

- E. Lightly dress slopes with topsoil to ensure close contact between fabric and soil.
  - F. At sides of ditches, lay fabric laps in direction of water flow. Lap ends and edges minimum 6 inches.
  - G. For placement in ditch lines, unroll erosion control blankets and turf reinforcement matting parallel to the centerline of the ditch. Blankets and matting unrolled parallel to the centerline shall extend a minimum of 3 feet up the front and back slopes. Longitudinal joints between adjoining blankets shall not be within 12 inches of the centerline of the ditch. Stagger end joints of adjacent blankets.
  - H. The placement and stapling of erosion control blankets and turf reinforcement matting shall follow application of seed and fertilizer on the same day. However, ENGINEER may require that erosion control blanket and turf reinforcement matting placement and stapling precede application of seed and fertilizer when the condition of the soil warrants an immediate erosion control measure.
- 3.6 OVERLAP
- A. Hydroseeding, temporary cover, and erosion control blanket shall overlap adjoining vegetation by 12 inches.
- 3.7 MAINTENANCE FOR SEED ESTABLISHMENT
- A. Start maintenance immediately after area seeded.
  - B. Maintain seeded area for not less than the period stated below and longer, as required to establish an acceptable stand, as determined by ENGINEER:
    - 1. Not less than 60 days after last area seeded.
    - 2. If planted in fall and not given full 60 days of maintenance, or if not considered acceptable by ENGINEER as specified in Paragraph 3.7 E, at completion of 60 days continue maintenance the following spring until acceptable vegetative cover is established.
  - C. Maintain vegetative cover by watering, fertilizing, weeding, mowing, trimming, overseeding, and other operations such as rolling, regrading, and replanting as required to establish a smooth, acceptable grassed surface, free of eroded or bare areas. After dormant seeding, monitoring of soil moisture and watering is not required to start until March.
  - D. Cutting Height: Mow vegetative cover as soon as there is enough top growth to cut with mower set at the specified height for the principal species planted. Repeat mowing as required to maintain specified height. Do not remove more than 1/3 of grass height. Do not mow when grass is wet. Time initial and subsequent mowings as required to maintain the following grass height: Mow grass at 4- to 5-inch height. Do not cut more than 1/3 of grass blade at any 1 mowing.
  - E. Vegetative cover will be accepted by ENGINEER provided all requirements have been complied with, including completion of 60-day maintenance period, and the following.

1. Vegetative cover is properly established.
2. Turf is free of eroded, bare, or dead spots and 98 percent free of weeds.
3. No surface is visible when vegetative cover has been cut to a height of 4 to 5 inches.

F. Immediately re-seed areas which show signs of bare spots.

### 3.8 CLEANING

- A. Clean up immediately, soil, mulch, or other debris spilled onto pavement and dispose of deleterious materials.
- B. Take precautions and prevent contamination by seeding and mulching slurry of structures, signs, guardrails, fences, utilities, or other surfaces not specified to be landscaped.
- C. Where contamination occurs, remove seeding slurry to satisfaction of, and by means approved by ENGINEER.

### 3.9 PROTECTION OF FINISHED WORK

- A. Protect landscaped areas from damage.

END OF SECTION



## APPENDIX F

### STORMWATER MANAGEMENT PLAN



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## 1.0 INTRODUCTION

This report presents the Storm Water Management (SWM) Plan for the Atkemix Ten South Landfill and Curtain Area (Site), located in Louisville, Kentucky.

This report provides a hydrologic analysis of the Site and its contributing drainage area. The analysis was used to calculate the change in runoff peak flows and volumes between existing conditions and the proposed conditions following regrading and retrofit of the landfill with a new cap system. This analysis was prepared to present the design of the supporting stormwater management measures.

### 1.1 OBJECTIVE

The overall objective of this stormwater management plan is to collect and safely convey surface runoff from the Site.

To achieve this objective, this proposed stormwater management plan describes how surface runoff will be conveyed from the newly capped portions of the South Landfill and adjacent area, resembling existing conditions drainage patterns as closely as possible. This will result in an improvement in stormwater management at the Site.

## 2.0 EXISTING SITE CONDITIONS

### 2.1 SITE LOCATION

A flood control levee is located east of the Site that runs parallel to the Ohio River.

### 2.2 SURFACE WATER DRAINAGE

The nearest water body is the Ohio River located approximately 200 feet west of the property.

Distinct drainage areas (Catchments) are identified on Figure F.1 and described below. Figure F.2 presents a schematic of the existing surface water drainage conditions.

Surface runoff from Catchment 100 drains westerly into Catchment 101 which has an existing swale that conveys concentrated flow southerly towards Catchment 105. In addition, runoff from Catchment 102 flows westerly into Catchment 103. Surface runoff from Catchments 103 and 104, and concentrated flow from the existing swale in Catchment 101 drains into Catchment 105 which is composed primarily of an existing swale flowing westerly. Surface runoff from Catchment 106 and concentrated flow from the existing swale in Catchment 105 drains into Catchment 107 which is also composed of an existing swale lined with existing riprap. Concentrated flow from Catchment 107 appears to spread and flow westerly as overland flow towards the Ohio River.

Surface runoff from Catchment 200 flows westerly as overland flow to Catchment 201; over the floodwall easement and off Site towards the Ohio River.

Surface runoff from Catchments 300 and 305 flows into Catchments 301 and 306, respectively. Overland flow is routed from Catchment 301 into Catchments 302, 303, and 304. Catchment 306 also flows into Catchment 304. Catchment 304 consists of an existing swale lined with riprap adjacent to a gravel road that conveys flow to a 15-inch pipe culvert located at the north westerly tip of the catchment. There is an existing riprap apron downstream of the culvert located at the westerly edge of Catchment 310. Catchment 307 flows primarily into Catchment 308. Catchments 308 and 309 sheetflow into Catchment 310. As a factor of safety, flow from Catchment 310 was routed into Catchment 304 and, as a result, the existing swale in Catchment 304.

### 2.3 SOIL COVER

Surface soils at the Site are predominantly topsoil and therefore classified as loam. Therefore, a hydrologic group unit B/C (loam was chosen when selecting the SCS Curve Number). The Site is primarily vegetated with grass and there are small portions of the Site that consist of wooded areas.

### 3.0 PROPOSED SITE CONDITIONS

Areas on Site will be excavated and backfilled to existing conditions. The excavated material will be consolidated on the South Landfill and capped. There will be 4 inches of topsoil placed on these areas; consequently, proposed conditions will have the same hydrologic group unit as existing conditions. Distinct drainage areas (Catchments) with the proposed contours are identified on Figure F.3 and described below. Figure F.4 presents a schematic of the existing surface water drainage conditions.

Surface runoff from Catchment 100 drains westerly into Catchment 101 which conveys flow into a new Swale 1 that conveys concentrated flow southerly towards Catchment 107. In addition, runoff from Catchments 103 and 105 flows into Catchments 104 and 106, respectively. Surface runoff from Catchments 104 and 106, and concentrated flow from the new Swale 1 in Catchment 101 drains into Catchment 107 which is composed primarily of an existing swale flowing westerly. Surface runoff from Catchment 108 and concentrated flow from the existing swale in Catchment 107 drains into Catchment 109 which is also composed an existing swale lined with existing riprap. Concentrated flow from Catchment 109 appears to spread and flow westerly as overland flow towards the Ohio River.

Surface runoff from Catchment 200 drains into Catchment 201 and Catchment 202 is routed to Catchments 203 and 204. These catchments experience flows westerly as overland flow; over the floodwall easement and off Site towards the Ohio River.

Surface runoff from Catchment 303 flows into Catchment 305. Overland flow is routed from Catchment 300 into Catchments 301 and 302. Catchment 305 also flows into Catchment 302. Catchment 302 consists of a new Swale 2, lined with permanent turf reinforcement matting and located adjacent to a gravel road. New Swale 2 conveys flow to a new 18-inch Culvert 2 located at the northwesterly tip of the catchment. There is a new Culvert 2 downstream apron located at the westerly edge of Catchment 310. Catchment 306 flows primarily into Catchment 307. Catchments 307 and 308 sheetflow into Catchment 309. As a factor of safety, flow from Catchment 309 was routed into Catchment 302 and, as a result, the new Swale 2 in Catchment 302.

#### 4.0 HYDROLOGIC ANALYSIS

The hydrologic analysis was completed to calculate peak flows and runoff volumes from the Site under various Site development scenarios and storm event conditions. The computer model HEC-HMS (Hydrologic Modeling System) was used to complete the modeling. The modeling was used to provide a basis for identifying and sizing appropriate surface water management features on the Site. Model input parameters include design storms, topographic features (drainage area, flow length, slope, and roughness), soil parameters (antecedent moisture conditions, infiltration capacity), ground cover conditions, and drainage paths.

The 1, 2, 5, 10, 25, 50, and 100-year design storm events were considered in the hydrologic modeling to provide a design basis for on-Site SWM features. The Rainfall Intensity Duration Frequency Values for each of these storm events are presented in Table F.1.

#### 4.1 EXISTING CONDITIONS HYDROLOGIC MODEL

The existing conditions model assumes land covers that are represented by a mix of grassland and landfill areas. Existing drainage patterns at the Site are shown on Figure F.2. The areas surrounding the Site are commercial and industrial properties.

The subcatchment parameters used to represent existing conditions and relevant calculations in the hydrologic model are summarized in Attachment F-1. A flow schematic representing catchment connectivity in the existing conditions hydrologic model is presented on Figure F.2. The hydrologic modelling output representing existing conditions is provided in Attachment F-3. The results of the existing conditions analysis were used to calculate allowable release rates under post-development conditions.

#### 4.2 PROPOSED CONDITIONS HYDROLOGIC MODEL

Areas of the Site will be excavated, re-graded, and capped. The construction of the proposed cap will reduce infiltration of precipitation and will alter runoff characteristics of the Site, resulting in a slight increase in runoff peak flow rates and volumes necessitating the upgraded SWM measures proposed in this report.

The subcatchment parameters used to represent proposed conditions and relevant calculations in the hydrologic model are summarized in Attachment F-2. A flow schematic representing catchment connectivity in the proposed conditions hydrologic model is presented on Figure F.4. The hydrologic modeling output representing proposed conditions is provided in Attachment F-4.

#### 4.3 MODELING RESULTS

Tables F.2 and F.3 provide a summary of calculated Site runoff volumes and Site runoff peak flow rates, respectively, for each design storm considered. For the Ohio River outlet and for each of the design storms analyzed (1, 2, 5, 10, 25, 50, and 100-year design storms), peak runoff flows are about 1 to 4 percent greater in proposed conditions which is insignificant given the accuracy of the model and assumptions used for the modeling.

## 5.0 PROPOSED STORMWATER MANAGEMENT PLAN

### 5.1 OBJECTIVES

The general objective of the SWM Plan is to control the direction, quality, and quantity of surface water runoff from the re-capped landfill in a manner that is practical and effective, and a series of surface water features to collect and direct surface water runoff from the Site.

### 5.2 PROPOSED STORMWATER MANAGEMENT SYSTEM

The proposed stormwater management system consists of new swales, culverts, and a downstream apron. The design of these features is summarized in Table F.4 and design calculations are demonstrated in Attachment F-5. Drawing C-05 also outlines the location and details of the proposed stormwater management features. A summary is provided below.

Construct a new Swale 1 along the southeast edge of the Site. Basically, an existing swale is already in place at that location. However, the intent is to extend the existing swale further northwards by about 150 feet. The total length of the new swale is 400 feet. The dimensions of the proposed swale are similar to those of the existing swale in order to minimize disturbance. New Swale 1 resembles the surface water drainage patterns of existing conditions; it diverts flow southerly towards the existing swale (located on the south edge of the Site) which in turn conveys flow westerly towards the Ohio River.

Reconstruct a new Swale 2 adjacent to the gravel road on the northwest side of the Site. Again, an existing swale lined with riprap already exists at this location. However, the soil and riprap are contaminated and will be excavated. Consequently, a new Swale 2 in the same location is designed with permanent turf reinforcement matting to safely convey the 25-year storm event peak flow. A new Culvert 2 is designed to convey the flow from the new Swale 2 into a new Culvert 2 downstream apron. An existing downstream riprap apron will also be removed and replaced with a new Culvert 2 downstream apron reinforced with permanent turf reinforcement matting.

## 6.0 CONCLUSION

The stormwater management system proposed in this report was designed to convey flows for all storm events up to and including the 25-year storm event in accordance with current environmental guidelines.

There is no incremental increase in the discharge rate from the Site as a result of the proposed capping improvements.

**TABLE F.1**  
**DESIGN STORM PARAMETERS**  
**STORMWATER MANAGEMENT PLAN**  
**ATKEMIX TEN INC.**  
**LOUISVILLE, KENTUCKY**

<i>Design Storm</i>	<i>Total Rainfall Depth<sup>(1)</sup></i> <i>(inches)</i>	<i>Duration</i> <i>(hours)</i>
1-Year	2.75	24
2-Year	3.15	24
5-Year	3.95	24
10-Year	4.40	24
25-Year	5.15	24
50-Year	5.60	24
100-Year	6.20	24

Note:

- (1) Rainfall depths determined from NOAA Technical Paper 40 rainfall frequency atlas of the United States.



TABLE F.2

SUMMARY OF RUNOFF VOLUMES  
STORMWATER MANAGEMENT PLAN  
ATKEMIX TEN INC.  
LOUISVILLE, KENTUCKY

## Existing Conditions

<i>Subcatchment</i>	<i>1-Year (ac ft)</i>	<i>2-Year (ac ft)</i>	<i>5-Year (ac ft)</i>	<i>10-Year (ac ft)</i>	<i>25-Year (ac ft)</i>	<i>50-Year (ac ft)</i>	<i>100-Year (ac ft)</i>
100	0.0	0.0	0.0	0.1	0.1	0.1	0.1
101	0.0	0.0	0.0	0.1	0.1	0.1	0.1
102	0.0	0.0	0.0	0.0	0.0	0.0	0.0
103	0.0	0.0	0.1	0.1	0.1	0.1	0.1
104	0.0	0.0	0.1	0.1	0.1	0.1	0.1
105	0.0	0.0	0.0	0.0	0.0	0.0	0.0
106	0.0	0.0	0.0	0.0	0.1	0.1	0.1
107	0.0	0.0	0.0	0.0	0.0	0.0	0.0
200	0.1	0.1	0.1	0.1	0.2	0.2	0.2
201	0.0	0.0	0.1	0.1	0.1	0.1	0.1
300	0.0	0.0	0.0	0.0	0.0	0.0	0.0
301	0.0	0.0	0.0	0.0	0.0	0.0	0.1
302	0.0	0.0	0.0	0.0	0.1	0.1	0.1
303	0.0	0.0	0.0	0.0	0.0	0.0	0.1
304	0.0	0.0	0.0	0.0	0.0	0.0	0.0
305	0.0	0.0	0.0	0.0	0.0	0.0	0.0
306	0.0	0.0	0.0	0.0	0.0	0.1	0.1
307	0.0	0.0	0.0	0.0	0.1	0.1	0.1
308	0.0	0.0	0.0	0.0	0.0	0.0	0.0
309	0.0	0.0	0.0	0.0	0.0	0.0	0.0
310	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Overland Sheetflow to Ohio River	0.4	0.5	0.7	0.8	1.1	1.2	1.4

TABLE F.2

SUMMARY OF RUNOFF VOLUMES  
STORMWATER MANAGEMENT PLAN  
ATKEMIX TEN INC.  
LOUISVILLE, KENTUCKY

## Post Development Conditions

<i>Subcatchment</i>	<i>1-Year (ac ft)</i>	<i>2-Year (ac ft)</i>	<i>5-Year (ac ft)</i>	<i>10-Year (ac ft)</i>	<i>25-Year (ac ft)</i>	<i>50-Year (ac ft)</i>	<i>100-Year (ac ft)</i>
100	0.0	0.0	0.1	0.1	0.1	0.1	0.1
101	0.0	0.1	0.1	0.1	0.1	0.1	0.1
102	0.0	0.0	0.1	0.1	0.1	0.1	0.1
103	0.0	0.0	0.0	0.0	0.0	0.0	0.0
104	0.0	0.0	0.0	0.0	0.0	0.1	0.1
105	0.0	0.0	0.0	0.0	0.0	0.0	0.0
106	0.0	0.0	0.1	0.1	0.1	0.1	0.1
107	0.0	0.0	0.0	0.0	0.0	0.0	0.0
108	0.0	0.0	0.1	0.1	0.1	0.1	0.1
109	0.0	0.0	0.0	0.0	0.0	0.0	0.0
200	0.0	0.0	0.0	0.0	0.1	0.1	0.1
201	0.0	0.0	0.0	0.1	0.1	0.1	0.1
202	0.0	0.0	0.0	0.0	0.0	0.0	0.0
203	0.0	0.0	0.0	0.0	0.0	0.0	0.0
204	0.0	0.0	0.0	0.0	0.0	0.0	0.0
300	0.0	0.0	0.0	0.0	0.0	0.1	0.1
301	0.0	0.0	0.0	0.0	0.0	0.0	0.0
302	0.0	0.0	0.0	0.0	0.0	0.0	0.0
303	0.0	0.0	0.0	0.0	0.0	0.0	0.0
304	0.0	0.0	0.0	0.0	0.0	0.0	0.0
305	0.0	0.0	0.0	0.1	0.1	0.1	0.1
306	0.0	0.0	0.0	0.0	0.1	0.1	0.1
307	0.0	0.0	0.0	0.0	0.0	0.0	0.0
308	0.0	0.0	0.0	0.0	0.0	0.0	0.0
309	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Overland Sheetflow to Ohio River	0.4	0.5	0.7	0.8	1.0	1.2	1.4

TABLE F.3

SUMMARY OF RUNOFF PEAK FLOWS  
STORMWATER MANAGEMENT PLAN  
ATKEMIX TEN INC.  
LOUISVILLE, KENTUCKY

## Existing Conditions

<i>(cfs)</i>	<i>1-Year (cfs)</i>	<i>2-Year (cfs)</i>	<i>5-Year (cfs)</i>	<i>10-Year (cfs)</i>	<i>25-Year (cfs)</i>	<i>50-Year (cfs)</i>	<i>100-Year (cfs)</i>
100	0.5	0.7	0.9	1.1	1.4	1.5	1.8
101	0.5	0.7	0.9	1.1	1.4	1.5	1.8
102	0.2	0.3	0.4	0.5	0.6	0.7	0.8
103	0.7	0.9	1.3	1.5	1.9	2.1	2.4
104	0.6	0.8	1.2	1.3	1.7	1.9	2.1
105	0.1	0.1	0.2	0.2	0.3	0.3	0.4
106	0.5	0.6	0.8	1.0	1.2	1.4	1.6
107	0.1	0.1	0.2	0.2	0.2	0.3	0.3
200	1.2	1.5	2.1	2.4	3.0	3.4	3.9
201	0.6	0.8	1.1	1.3	1.7	1.9	2.1
300	0.2	0.3	0.4	0.5	0.6	0.7	0.8
301	0.4	0.4	0.6	0.7	0.9	1.0	1.2
302	0.4	0.5	0.8	0.9	1.1	1.3	1.4
303	0.3	0.4	0.6	0.7	0.9	1.0	1.2
304	0.3	0.3	0.5	0.5	0.7	0.7	0.8
305	0.1	0.2	0.3	0.3	0.4	0.4	0.5
306	0.4	0.5	0.7	0.8	1.0	1.1	1.2
307	0.4	0.5	0.7	0.8	1.0	1.1	1.3
308	0.1	0.1	0.2	0.2	0.3	0.3	0.4
309	0.0	0.0	0.0	0.0	0.0	0.1	0.1
310	0.3	0.4	0.5	0.6	0.8	0.9	1.0
Overland Sheetflow to Ohio River	7.5	9.5	13.5	15.9	19.8	22.2	25.4

TABLE F.3

SUMMARY OF RUNOFF PEAK FLOWS  
STORMWATER MANAGEMENT PLAN  
ATKEMIX TEN INC.  
LOUISVILLE, KENTUCKY

## Post Development Conditions

<i>Subcatchment</i>	<i>1-Year (cfs)</i>	<i>2-Year (cfs)</i>	<i>5-Year (cfs)</i>	<i>10-Year (cfs)</i>	<i>25-Year (cfs)</i>	<i>50-Year (cfs)</i>	<i>100-Year (cfs)</i>
100	0.8	1.0	1.4	1.6	2.0	2.2	2.5
101	0.9	1.1	1.6	1.8	2.3	2.6	2.9
102	0.7	0.9	1.3	1.5	1.9	2.1	2.4
103	0.2	0.3	0.4	0.5	0.6	0.7	0.8
104	0.1	0.2	0.4	0.6	0.9	1.0	1.3
105	0.1	0.1	0.2	0.2	0.3	0.3	0.4
106	0.6	0.7	1.0	1.2	1.5	1.6	1.9
107	0.1	0.1	0.2	0.2	0.3	0.3	0.4
108	0.6	0.7	1.0	1.2	1.5	1.7	1.9
109	0.1	0.1	0.2	0.2	0.2	0.3	0.3
200	0.5	0.6	0.8	1.0	1.2	1.4	1.5
201	0.5	0.7	0.9	1.1	1.4	1.5	1.8
202	0.1	0.2	0.2	0.3	0.3	0.4	0.4
203	0.2	0.2	0.3	0.4	0.4	0.5	0.6
204	0.2	0.2	0.3	0.4	0.5	0.5	0.6
300	0.4	0.5	0.7	0.8	1.0	1.2	1.3
301	0.2	0.2	0.3	0.3	0.4	0.4	0.5
302	0.3	0.3	0.5	0.5	0.7	0.7	0.8
303	0.1	0.2	0.3	0.3	0.4	0.4	0.5
304	0.0	0.1	0.1	0.1	0.1	0.1	0.1
305	0.5	0.6	0.8	1.0	1.2	1.4	1.6
306	0.4	0.5	0.7	0.8	1.0	1.1	1.3
307	0.1	0.1	0.2	0.2	0.3	0.3	0.4
308	0.0	0.0	0.0	0.0	0.0	0.1	0.1
309	0.3	0.4	0.5	0.6	0.8	0.9	1.0
Overland Sheetflow to Ohio River	7.6	9.6	13.9	16.3	20.5	23.1	26.5

**TABLE F.4**  
**SWALE AND CULVERT DESIGN**  
**STORMWATER MANAGEMENT PLAN**  
**ATKEMIX TEN INC.**  
**LOUISVILLE, KENTUCKY**

Conveyance	25 yr Storm Peak flow <sup>1</sup>	Length	Upstream Elevation	Downstream Elevation	Minimum Slope	Diameter	Bottom Width	Right Side Slopes	Left Side Slopes	Peak flow Depth <sup>2</sup>	Velocity <sup>2</sup>	Maximum Flow Capacity	Minimum Design Depth	Channel Lining
	(cfs)	(ft)	(ft AMSL)	(ft AMSL)	(%)	(in)	(ft)	(H:V)	(H:V)	(ft)	(fps)	(cfs)	(ft)	
Swale 1	6.2	400.0	453.0	450.5	0.6%	-	10	20:1	20:1	0.2	2.6	42.5	0.5	Type D Vegetation
Swale 2	5.7	160.0	451.8	435.0	10.5%	-	2	3:1	3:1	0.27	7.8	41.8	1.0	LANDLOK 450 Turf Reinforcement Mat
Culvert 2	5.7	25.0	435.0	434.0	4.0%	18.0	-	-	-	0.8	6.6	12.2	1.5	-
Culvert 2 Apron <sup>3</sup>	5.7	33.0	434.5	428.5	18.2%	-	4	10:1	10:1	0.2	4.9	11.7	0.3	LANDLOK 450 Turf Reinforcement Mat

## Notes:

1. The 25-year peak flows are obtained from HEC-HMS.
2. The velocity and peak flow depth are calculated for the 25-year storm event. Attachment F-5 contains the rating tables for the swales and culvert.
3. The Culvert 2 downstream apron was modeled as a trapezoidal channel for hydraulic analysis. However, the trapezoidal channel profile provided is only accurate at the upstream end of the apron. Immediately downstream of the culvert, the apron bottom width and side slopes of the apron should begin to expand for about 33 ft (a 2:1 (L:W) ratio of expansion is preferred).

## ATTACHMENT F-1

EXISTING CONDITIONS HYDROLOGIC MODELING SUBCATCHMENT PARAMETERS CALCULATION  
 STORMWATER MANAGEMENT PLAN  
 ATKEMIX TEN INC.  
 LOUISVILLE, KENTUCKY

Subcatchment	Area (ac)	Area (mi <sup>2</sup> )	Impervious (%)	Length (ft)	Slope (%)	Pervious CN (-)	Abstraction <sup>3</sup> (in)	Tc -calculated <sup>5</sup> (min)
100	0.238	0.000372	0.0%	36	23.600	83	0.42	0.42
101	0.239	0.000373	0.0%	25	3.780	83	0.41	0.78
102	0.105	0.000164	0.0%	50	16.000	83	0.41	0.66
103	0.340	0.000532	0.0%	69	5.150	62	1.21	2.70
104	0.328	0.000512	0.0%	136	1.800	83	0.41	4.36
105	0.063	0.000099	0.0%	10	10.000	72	0.80	0.32
106	0.220	0.000344	0.0%	180	14.370	83	0.41	1.93
107	0.041	0.000064	50.0%	10	30.000	72	0.78	0.18
200	0.630	0.000984	0.0%	158	1.266	83	0.41	5.86
201	0.290	0.000453	0.0%	44	6.800	83	0.41	0.91
300	0.103	0.000161	0.0%	20	27.500	83	0.41	0.24
301	0.160	0.000250	0.0%	28	5.357	83	0.41	0.71
302	0.214	0.000335	0.0%	100	1.500	83	0.41	3.74
303	0.160	0.000250	0.0%	54	4.321	83	0.41	1.34
304	0.108	0.000169	15.0%	50	25.952	83	0.41	0.52
305	0.065	0.000101	0.0%	22	25.065	83	0.41	0.27
306	0.178	0.000279	0.0%	136	3.309	83	0.41	3.22
307	0.186	0.000291	0.0%	102	1.961	83	0.41	3.32
308	0.072	0.000112	0.0%	45	10.000	72	0.78	1.06
309	0.020	0.000032	0.0%	17	47.430	60	1.33	0.31
310	0.140	0.000219	5.0%	155	9.677	83	0.41	2.09
Total	3.9	0.006097						

## Notes:

1. The Site currently has approximately 12" of rooting zone and 6" of topsoil (loam). Therefore, a hydrologic group unit B/C (loam) was chosen when selecting the SCS Curve Number.
2. The subcatchments are poor condition grass with a CN of 83, fair condition woods with a CN of 60. For subcatchments that are a mixture of grass and woods, an area weighted CN was used.
3. An initial abstraction of  $I = 0.2 \cdot S$  (soil storage) was chosen.
4. CN were referenced from Technical Release 55.
5. SCS Lag Formula (SCS, 1972):  $T_c = 0.00526 \cdot L^{0.8} \cdot (1000 / CN - 9)^{0.7} \cdot S^{-0.5}$

## ATTACHMENT F-2

PROPOSED CONDITIONS HYDROLOGIC MODELING SUBCATCHMENT PARAMETERS CALCULATION  
STORMWATER MANAGEMENT PLAN  
ATKEMIX TEN INC.  
LOUISVILLE, KENTUCKY

Subcatchment	Area (ac)	Area (mi <sup>2</sup> )	Impervious (%)	Length (ft)	Slope (%)	Pervious CN (-)	Abstraction <sup>3</sup> (in)	Tc -calculated <sup>5</sup> (min)
100	0.340	0.000531	0.0%	36	23.600	83	0.41	0.42
101	0.400	0.000625	0.0%	25	3.780	83	0.41	0.78
102	0.330	0.000516	0.0%	50	24.000	83	0.41	0.54
103	0.105	0.000164	0.0%	50	16.000	83	0.41	0.66
104	0.340	0.000532	0.0%	69	5.150	62	1.23	2.72
105	0.050	0.000078	0.0%	50	24.000	83	0.41	0.54
106	0.290	0.000453	0.0%	150	1.800	83	0.41	4.72
107	0.063	0.000099	0.0%	10	10.000	72	0.78	0.32
108	0.270	0.000422	0.0%	180	14.370	83	0.41	1.93
109	0.041	0.000064	50.0%	10	30.000	72	0.78	0.18
200	0.210	0.000328	0.0%	75	20.000	83	0.41	0.81
201	0.240	0.000375	0.0%	44	6.800	83	0.41	0.91
202	0.060	0.000094	0.0%	50	24.000	83	0.41	0.54
203	0.080	0.000125	0.0%	44	1.800	83	0.41	1.77
204	0.080	0.000125	0.0%	44	6.800	83	0.41	0.91
300	0.180	0.000281	0.0%	70	20.000	83	0.41	0.77
301	0.070	0.000109	0.0%	40	6.800	83	0.41	0.84
302	0.108	0.000169	15.0%	50	25.952	83	0.41	0.52
303	0.065	0.000101	0.0%	22	25.065	83	0.41	0.27
304	0.020	0.000031	0.0%	25	24.000	83	0.41	0.31
305	0.230	0.000359	0.0%	136	3.309	83	0.41	3.22
306	0.186	0.000291	0.0%	102	1.961	83	0.41	3.32
307	0.072	0.000112	0.0%	45	10.000	72	0.78	1.06
308	0.020	0.000032	0.0%	17	47.430	60	1.33	0.31
309	0.140	0.000219	0.0%	155	9.677	83	0.41	2.09
Total	4.0	0.006236						

## Notes:

1. The Site currently has approximately 12" of rooting zone and 6" of topsoil (loam). Therefore, a hydrologic group unit B/C (loam) was chosen when selecting the SCS Curve Number.
2. The subcatchments are poor condition grass with a CN of 83, fair condition woods with a CN of 60. For subcatchments that are a mixture of grass and woods, an area weighted CN was used.
3. An initial abstraction of  $I = 0.2 \cdot S$  (soil storage) was chosen.
4. CN were referenced from Technical Release 55.
5. SCS Lag Formula (SCS, 1972):  $T_c = 0.00526 \cdot L^{0.8} \cdot (1000/CN-9)^{0.7} \cdot S^{-0.5}$



## ATTACHMENT F-3

EXISTING HYDROLOGIC MODELING OUTPUT  
 STORMWATER MANAGEMENT PLAN  
 ATKEMIX TEN INC.  
 LOUISVILLE, KENTUCKY

## 1-Year Storm Event

<i>Hydrologic Element</i>	<i>Drainage Area (mi<sup>2</sup>)</i>	<i>Peak Discharge (cfs)</i>	<i>Time</i>	<i>Volume (ac-ft)</i>
100	0.000372	0.5	01Jan2009, 12:54	0
101	0.000373	0.5	01Jan2009, 12:54	0
102	0.000164	0.2	01Jan2009, 12:54	0
103	0.000532	0.7	01Jan2009, 12:55	0
104	0.000512	0.6	01Jan2009, 12:58	0
105	0.000099	0.1	01Jan2009, 12:54	0
106	0.000344	0.5	01Jan2009, 12:55	0
107	0.000064	0.1	01Jan2009, 12:53	0
200	0.000984	1.2	01Jan2009, 13:00	0.1
201	0.000453	0.6	01Jan2009, 12:54	0
300	0.000161	0.2	01Jan2009, 12:54	0
301	0.00025	0.4	01Jan2009, 12:54	0
302	0.000335	0.4	01Jan2009, 12:57	0
303	0.00025	0.3	01Jan2009, 12:55	0
304	0.000169	0.3	01Jan2009, 12:53	0
305	0.000101	0.1	01Jan2009, 12:54	0
306	0.000279	0.4	01Jan2009, 12:57	0
307	0.000291	0.4	01Jan2009, 12:57	0
308	0.000112	0.1	01Jan2009, 12:55	0
309	0.000032	0	01Jan2009, 12:57	0
310	0.000219	0.3	01Jan2009, 12:55	0
Junction 100	0.000745	1.1	01Jan2009, 12:54	0
Junction-105	0.002052	2.6	01Jan2009, 12:55	0.1
Junction-107	0.00246	3.2	01Jan2009, 12:55	0.2
Junction-2	0.001437	1.6	01Jan2009, 12:58	0.1
Junction-3	0.002199	2.8	01Jan2009, 12:55	0.1
Junction-304	0.001165	1.6	01Jan2009, 12:55	0.1
Junction-306	0.00038	0.5	01Jan2009, 12:56	0
Junction-310	0.000654	0.8	01Jan2009, 12:56	0
Sink-1	0.006096	7.5	01Jan2009, 12:55	0.4

## ATTACHMENT F-3

EXISTING HYDROLOGIC MODELING OUTPUT  
 STORMWATER MANAGEMENT PLAN  
 ATKEMIX TEN INC.  
 LOUISVILLE, KENTUCKY

## 2-Year Storm Event

<i>Hydrologic Element</i>	<i>Drainage Area (mi<sup>2</sup>)</i>	<i>Peak Discharge (cfs)</i>	<i>Time</i>	<i>Volume (ac-ft)</i>
100	0.000372	0.7	01Jan2009, 12:53	0
101	0.000373	0.7	01Jan2009, 12:54	0
102	0.000164	0.3	01Jan2009, 12:54	0
103	0.000532	0.9	01Jan2009, 12:55	0
104	0.000512	0.8	01Jan2009, 12:58	0
105	0.000099	0.1	01Jan2009, 12:54	0
106	0.000344	0.6	01Jan2009, 12:55	0
107	0.000064	0.1	01Jan2009, 12:53	0
200	0.000984	1.5	01Jan2009, 13:00	0.1
201	0.000453	0.8	01Jan2009, 12:54	0
300	0.000161	0.3	01Jan2009, 12:53	0
301	0.00025	0.4	01Jan2009, 12:54	0
302	0.000335	0.5	01Jan2009, 12:57	0
303	0.00025	0.4	01Jan2009, 12:54	0
304	0.000169	0.3	01Jan2009, 12:53	0
305	0.000101	0.2	01Jan2009, 12:53	0
306	0.000279	0.5	01Jan2009, 12:57	0
307	0.000291	0.5	01Jan2009, 12:57	0
308	0.000112	0.1	01Jan2009, 12:55	0
309	0.000032	0	01Jan2009, 12:56	0
310	0.000219	0.4	01Jan2009, 12:55	0
Junction 100	0.000745	1.3	01Jan2009, 12:54	0.1
Junction-105	0.002052	3.3	01Jan2009, 12:55	0.2
Junction-107	0.00246	4	01Jan2009, 12:55	0.2
Junction-2	0.001437	2.1	01Jan2009, 12:57	0.1
Junction-3	0.002199	3.5	01Jan2009, 12:55	0.2
Junction-304	0.001165	2	01Jan2009, 12:54	0.1
Junction-306	0.00038	0.6	01Jan2009, 12:56	0
Junction-310	0.000654	1	01Jan2009, 12:56	0
Sink-1	0.006096	9.5	01Jan2009, 12:55	0.5

## ATTACHMENT F-3

EXISTING HYDROLOGIC MODELING OUTPUT  
 STORMWATER MANAGEMENT PLAN  
 ATKEMIX TEN INC.  
 LOUISVILLE, KENTUCKY

## 5-yr Storm Event

<i>Hydrologic Element</i>	<i>Drainage Area (mi<sup>2</sup>)</i>	<i>Peak Discharge (cfs)</i>	<i>Time</i>	<i>Volume (ac-ft)</i>
100	0.000372	0.9	01Jan2009, 12:53	0
101	0.000373	0.9	01Jan2009, 12:54	0
102	0.000164	0.4	01Jan2009, 12:53	0
103	0.000532	1.3	01Jan2009, 12:55	0.1
104	0.000512	1.2	01Jan2009, 12:58	0.1
105	0.000099	0.2	01Jan2009, 12:54	0
106	0.000344	0.8	01Jan2009, 12:55	0
107	0.000064	0.2	01Jan2009, 12:53	0
200	0.000984	2.1	01Jan2009, 12:59	0.1
201	0.000453	1.1	01Jan2009, 12:54	0.1
300	0.000161	0.4	01Jan2009, 12:53	0
301	0.00025	0.6	01Jan2009, 12:53	0
302	0.000335	0.8	01Jan2009, 12:57	0
303	0.00025	0.6	01Jan2009, 12:54	0
304	0.000169	0.5	01Jan2009, 12:53	0
305	0.000101	0.3	01Jan2009, 12:53	0
306	0.000279	0.7	01Jan2009, 12:57	0
307	0.000291	0.7	01Jan2009, 12:57	0
308	0.000112	0.2	01Jan2009, 12:54	0
309	0.000032	0	01Jan2009, 12:55	0
310	0.000219	0.5	01Jan2009, 12:55	0
Junction 100	0.000745	1.9	01Jan2009, 12:53	0.1
Junction-105	0.002052	4.7	01Jan2009, 12:54	0.2
Junction-107	0.00246	5.7	01Jan2009, 12:54	0.3
Junction-2	0.001437	2.9	01Jan2009, 12:57	0.2
Junction-3	0.002199	5.1	01Jan2009, 12:55	0.3
Junction-304	0.001165	2.8	01Jan2009, 12:54	0.1
Junction-306	0.00038	0.9	01Jan2009, 12:56	0
Junction-310	0.000654	1.4	01Jan2009, 12:56	0.1
Sink-1	0.006096	13.5	01Jan2009, 12:55	0.7

## ATTACHMENT F-3

EXISTING HYDROLOGIC MODELING OUTPUT  
 STORMWATER MANAGEMENT PLAN  
 ATKEMIX TEN INC.  
 LOUISVILLE, KENTUCKY

## 10-yr Storm Event

<i>Hydrologic Element</i>	<i>Drainage Area (mi<sup>2</sup>)</i>	<i>Peak Discharge (cfs)</i>	<i>Time</i>	<i>Volume (ac-ft)</i>
100	0.000372	1.1	01Jan2009, 12:53	0.1
101	0.000373	1.1	01Jan2009, 12:53	0.1
102	0.000164	0.5	01Jan2009, 12:53	0
103	0.000532	1.5	01Jan2009, 12:54	0.1
104	0.000512	1.3	01Jan2009, 12:58	0.1
105	0.000099	0.2	01Jan2009, 12:54	0
106	0.000344	1	01Jan2009, 12:55	0
107	0.000064	0.2	01Jan2009, 12:53	0
200	0.000984	2.4	01Jan2009, 12:59	0.1
201	0.000453	1.3	01Jan2009, 12:54	0.1
300	0.000161	0.5	01Jan2009, 12:53	0
301	0.00025	0.7	01Jan2009, 12:53	0
302	0.000335	0.9	01Jan2009, 12:57	0
303	0.00025	0.7	01Jan2009, 12:54	0
304	0.000169	0.5	01Jan2009, 12:53	0
305	0.000101	0.3	01Jan2009, 12:53	0
306	0.000279	0.8	01Jan2009, 12:56	0
307	0.000291	0.8	01Jan2009, 12:57	0
308	0.000112	0.2	01Jan2009, 12:54	0
309	0.000032	0	01Jan2009, 12:55	0
310	0.000219	0.6	01Jan2009, 12:55	0
Junction 100	0.000745	2.2	01Jan2009, 12:53	0.1
Junction-105	0.002052	5.5	01Jan2009, 12:54	0.3
Junction-107	0.00246	6.7	01Jan2009, 12:54	0.3
Junction-2	0.001437	3.4	01Jan2009, 12:57	0.2
Junction-3	0.002199	5.9	01Jan2009, 12:55	0.3
Junction-304	0.001165	3.3	01Jan2009, 12:54	0.2
Junction-306	0.00038	1	01Jan2009, 12:56	0.1
Junction-310	0.000654	1.7	01Jan2009, 12:56	0.1
Sink-1	0.006096	15.9	01Jan2009, 12:55	0.8

## ATTACHMENT F-3

EXISTING HYDROLOGIC MODELING OUTPUT  
 STORMWATER MANAGEMENT PLAN  
 ATKEMIX TEN INC.  
 LOUISVILLE, KENTUCKY

## 25-yr Storm Event

<i>Hydrologic Element</i>	<i>Drainage Area (mi<sup>2</sup>)</i>	<i>Peak Discharge (cfs)</i>	<i>Time</i>	<i>Volume (ac-ft)</i>
100	0.000372	1.4	01Jan2009, 12:53	0.1
101	0.000373	1.4	01Jan2009, 12:53	0.1
102	0.000164	0.6	01Jan2009, 12:53	0
103	0.000532	1.9	01Jan2009, 12:54	0.1
104	0.000512	1.7	01Jan2009, 12:58	0.1
105	0.000099	0.3	01Jan2009, 12:54	0
106	0.000344	1.2	01Jan2009, 12:55	0.1
107	0.000064	0.2	01Jan2009, 12:53	0
200	0.000984	3	01Jan2009, 12:59	0.2
201	0.000453	1.7	01Jan2009, 12:54	0.1
300	0.000161	0.6	01Jan2009, 12:53	0
301	0.00025	0.9	01Jan2009, 12:53	0
302	0.000335	1.1	01Jan2009, 12:57	0.1
303	0.00025	0.9	01Jan2009, 12:54	0
304	0.000169	0.7	01Jan2009, 12:53	0
305	0.000101	0.4	01Jan2009, 12:53	0
306	0.000279	1	01Jan2009, 12:56	0
307	0.000291	1	01Jan2009, 12:56	0.1
308	0.000112	0.3	01Jan2009, 12:54	0
309	0.000032	0	01Jan2009, 12:54	0
310	0.000219	0.8	01Jan2009, 12:55	0
Junction 100	0.000745	2.8	01Jan2009, 12:53	0.1
Junction-105	0.002052	6.9	01Jan2009, 12:54	0.4
Junction-107	0.00246	8.4	01Jan2009, 12:54	0.4
Junction-2	0.001437	4.3	01Jan2009, 12:57	0.3
Junction-3	0.002199	7.4	01Jan2009, 12:55	0.4
Junction-304	0.001165	4.1	01Jan2009, 12:54	0.2
Junction-306	0.00038	1.3	01Jan2009, 12:55	0.1
Junction-310	0.000654	2.1	01Jan2009, 12:56	0.1
Sink-1	0.006096	19.8	01Jan2009, 12:55	1.1

## ATTACHMENT F-3

EXISTING HYDROLOGIC MODELING OUTPUT  
 STORMWATER MANAGEMENT PLAN  
 ATKEMIX TEN INC.  
 LOUISVILLE, KENTUCKY

## 50-yr Storm Event

<i>Hydrologic Element</i>	<i>Drainage Area (mi<sup>2</sup>)</i>	<i>Peak Discharge (cfs)</i>	<i>Time</i>	<i>Volume (ac-ft)</i>
100	0.000372	1.5	01Jan2009, 12:53	0.1
101	0.000373	1.5	01Jan2009, 12:53	0.1
102	0.000164	0.7	01Jan2009, 12:53	0
103	0.000532	2.1	01Jan2009, 12:54	0.1
104	0.000512	1.9	01Jan2009, 12:58	0.1
105	0.000099	0.3	01Jan2009, 12:53	0
106	0.000344	1.4	01Jan2009, 12:55	0.1
107	0.000064	0.3	01Jan2009, 12:53	0
200	0.000984	3.4	01Jan2009, 12:59	0.2
201	0.000453	1.9	01Jan2009, 12:54	0.1
300	0.000161	0.7	01Jan2009, 12:53	0
301	0.00025	1	01Jan2009, 12:53	0
302	0.000335	1.3	01Jan2009, 12:57	0.1
303	0.00025	1	01Jan2009, 12:54	0
304	0.000169	0.7	01Jan2009, 12:53	0
305	0.000101	0.4	01Jan2009, 12:53	0
306	0.000279	1.1	01Jan2009, 12:56	0.1
307	0.000291	1.1	01Jan2009, 12:56	0.1
308	0.000112	0.3	01Jan2009, 12:54	0
309	0.000032	0.1	01Jan2009, 12:54	0
310	0.000219	0.9	01Jan2009, 12:55	0
Junction 100	0.000745	3.1	01Jan2009, 12:53	0.1
Junction-105	0.002052	7.7	01Jan2009, 12:54	0.4
Junction-107	0.00246	9.4	01Jan2009, 12:54	0.5
Junction-2	0.001437	4.8	01Jan2009, 12:57	0.3
Junction-3	0.002199	8.3	01Jan2009, 12:55	0.4
Junction-304	0.001165	4.6	01Jan2009, 12:54	0.2
Junction-306	0.00038	1.4	01Jan2009, 12:55	0.1
Junction-310	0.000654	2.4	01Jan2009, 12:55	0.1
Sink-1	0.006096	22.2	01Jan2009, 12:55	1.2

## ATTACHMENT F-3

EXISTING HYDROLOGIC MODELING OUTPUT  
 STORMWATER MANAGEMENT PLAN  
 ATKEMIX TEN INC.  
 LOUISVILLE, KENTUCKY

## 100-yr Storm Event

<i>Hydrologic Element</i>	<i>Drainage Area (mi<sup>2</sup>)</i>	<i>Peak Discharge (cfs)</i>	<i>Time</i>	<i>Volume (ac-ft)</i>
100	0.000372	1.8	01Jan2009, 12:53	0.1
101	0.000373	1.8	01Jan2009, 12:53	0.1
102	0.000164	0.8	01Jan2009, 12:53	0
103	0.000532	2.4	01Jan2009, 12:54	0.1
104	0.000512	2.1	01Jan2009, 12:58	0.1
105	0.000099	0.4	01Jan2009, 12:53	0
106	0.000344	1.6	01Jan2009, 12:55	0.1
107	0.000064	0.3	01Jan2009, 12:53	0
200	0.000984	3.9	01Jan2009, 12:59	0.2
201	0.000453	2.1	01Jan2009, 12:53	0.1
300	0.000161	0.8	01Jan2009, 12:53	0
301	0.00025	1.2	01Jan2009, 12:53	0.1
302	0.000335	1.4	01Jan2009, 12:57	0.1
303	0.00025	1.2	01Jan2009, 12:54	0.1
304	0.000169	0.8	01Jan2009, 12:53	0
305	0.000101	0.5	01Jan2009, 12:53	0
306	0.000279	1.2	01Jan2009, 12:56	0.1
307	0.000291	1.3	01Jan2009, 12:56	0.1
308	0.000112	0.4	01Jan2009, 12:54	0
309	0.000032	0.1	01Jan2009, 12:54	0
310	0.000219	1	01Jan2009, 12:55	0
Junction 100	0.000745	3.5	01Jan2009, 12:53	0.2
Junction-105	0.002052	8.9	01Jan2009, 12:54	0.5
Junction-107	0.00246	10.7	01Jan2009, 12:54	0.6
Junction-2	0.001437	5.5	01Jan2009, 12:57	0.3
Junction-3	0.002199	9.5	01Jan2009, 12:55	0.5
Junction-304	0.001165	5.2	01Jan2009, 12:54	0.3
Junction-306	0.00038	1.6	01Jan2009, 12:55	0.1
Junction-310	0.000654	2.7	01Jan2009, 12:55	0.1
Sink-1	0.006096	25.4	01Jan2009, 12:55	1.4



## ATTACHMENT F-4

PROPOSED HYDROLOGIC MODELING OUTPUT  
 STORMWATER MANAGEMENT PLAN  
 ATKEMIX TEN INC.  
 LOUISVILLE, KENTUCKY

## 1-Year Storm Event

<i>Hydrologic Element</i>	<i>Drainage Area (mi<sup>2</sup>)</i>	<i>Peak Discharge (cfs)</i>	<i>Time</i>	<i>Volume (ac-ft)</i>
100	0.000531	0.8	01Jan2009, 12:54	0
101	0.000625	0.9	01Jan2009, 12:54	0
102	0.000516	0.7	01Jan2009, 12:54	0
103	0.000164	0.2	01Jan2009, 12:54	0
104	0.000532	0.1	01Jan2009, 12:59	0
105	0.000078	0.1	01Jan2009, 12:54	0
106	0.000453	0.6	01Jan2009, 12:59	0
107	0.000099	0.1	01Jan2009, 12:54	0
108	0.000422	0.6	01Jan2009, 12:55	0
109	0.000064	0.1	01Jan2009, 12:53	0
200	0.000328	0.5	01Jan2009, 12:54	0
201	0.000375	0.5	01Jan2009, 12:54	0
202	0.000094	0.1	01Jan2009, 12:54	0
203	0.000125	0.2	01Jan2009, 12:55	0
204	0.000125	0.2	01Jan2009, 12:54	0
300	0.000281	0.4	01Jan2009, 12:54	0
301	0.000109	0.2	01Jan2009, 12:54	0
302	0.000169	0.3	01Jan2009, 12:53	0
303	0.000101	0.1	01Jan2009, 12:54	0
304	0.000031	0	01Jan2009, 12:54	0
305	0.000359	0.5	01Jan2009, 12:57	0
306	0.000291	0.4	01Jan2009, 12:57	0
307	0.000112	0.1	01Jan2009, 12:55	0
308	0.000032	0	01Jan2009, 12:57	0
309	0.000219	0.3	01Jan2009, 12:55	0
Junction-101	0.001672	2.4	01Jan2009, 12:54	0.1
Junction-106	0.002998	3.3	01Jan2009, 12:54	0.2
Junction-108	0.003484	4	01Jan2009, 12:54	0.2
Junction-2	0.001047	1.5	01Jan2009, 12:54	0.1
Junction-3	0.001704	2.2	01Jan2009, 12:55	0.1
Junction-301	0.000559	0.8	01Jan2009, 12:54	0
Junction-303	0.000491	0.6	01Jan2009, 12:56	0
Junction-304	0.000291	0.4	01Jan2009, 12:57	0
Junction-305	0.000403	0.5	01Jan2009, 12:57	0
Junction-307	0.000654	0.8	01Jan2009, 12:56	0
Sink-1	0.006235	7.6	01Jan2009, 12:55	0.4

## ATTACHMENT F-4

PROPOSED HYDROLOGIC MODELING OUTPUT  
 STORMWATER MANAGEMENT PLAN  
 ATKEMIX TEN INC.  
 LOUISVILLE, KENTUCKY

## 2-Year Storm Event

<i>Hydrologic Element</i>	<i>Drainage Area (mi<sup>2</sup>)</i>	<i>Peak Discharge (cfs)</i>	<i>Time</i>	<i>Volume (ac-ft)</i>
100	0.000531	1	01Jan2009, 12:53	0
101	0.000625	1.1	01Jan2009, 12:54	0.1
102	0.000516	0.9	01Jan2009, 12:53	0
103	0.000164	0.3	01Jan2009, 12:54	0
104	0.000532	0.2	01Jan2009, 12:58	0
105	0.000078	0.1	01Jan2009, 12:53	0
106	0.000453	0.7	01Jan2009, 12:58	0
107	0.000099	0.1	01Jan2009, 12:54	0
108	0.000422	0.7	01Jan2009, 12:55	0
109	0.000064	0.1	01Jan2009, 12:53	0
200	0.000328	0.6	01Jan2009, 12:54	0
201	0.000375	0.7	01Jan2009, 12:54	0
202	0.000094	0.2	01Jan2009, 12:53	0
203	0.000125	0.2	01Jan2009, 12:55	0
204	0.000125	0.2	01Jan2009, 12:54	0
300	0.000281	0.5	01Jan2009, 12:54	0
301	0.000109	0.2	01Jan2009, 12:54	0
302	0.000169	0.3	01Jan2009, 12:53	0
303	0.000101	0.2	01Jan2009, 12:53	0
304	0.000031	0.1	01Jan2009, 12:53	0
305	0.000359	0.6	01Jan2009, 12:57	0
306	0.000291	0.5	01Jan2009, 12:57	0
307	0.000112	0.1	01Jan2009, 12:55	0
308	0.000032	0	01Jan2009, 12:56	0
309	0.000219	0.4	01Jan2009, 12:55	0
Junction-101	0.001672	3	01Jan2009, 12:54	0.1
Junction-106	0.002998	4.2	01Jan2009, 12:54	0.2
Junction-108	0.003484	5	01Jan2009, 12:54	0.3
Junction-2	0.001047	1.9	01Jan2009, 12:54	0.1
Junction-3	0.001704	2.7	01Jan2009, 12:55	0.1
Junction-301	0.000559	1	01Jan2009, 12:54	0
Junction-303	0.000491	0.8	01Jan2009, 12:56	0
Junction-304	0.000291	0.5	01Jan2009, 12:57	0
Junction-305	0.000403	0.6	01Jan2009, 12:56	0
Junction-307	0.000654	1	01Jan2009, 12:56	0
Sink-1	0.006235	9.6	01Jan2009, 12:54	0.5

## ATTACHMENT F-4

PROPOSED HYDROLOGIC MODELING OUTPUT  
 STORMWATER MANAGEMENT PLAN  
 ATKEMIX TEN INC.  
 LOUISVILLE, KENTUCKY

## 5-yr Storm Event

<i>Hydrologic Element</i>	<i>Drainage Area (mi<sup>2</sup>)</i>	<i>Peak Discharge (cfs)</i>	<i>Time</i>	<i>Volume (ac-ft)</i>
100	0.000531	1.4	01Jan2009, 12:53	0.1
101	0.000625	1.6	01Jan2009, 12:54	0.1
102	0.000516	1.3	01Jan2009, 12:53	0.1
103	0.000164	0.4	01Jan2009, 12:53	0
104	0.000532	0.4	01Jan2009, 12:58	0
105	0.000078	0.2	01Jan2009, 12:53	0
106	0.000453	1	01Jan2009, 12:58	0.1
107	0.000099	0.2	01Jan2009, 12:54	0
108	0.000422	1	01Jan2009, 12:55	0.1
109	0.000064	0.2	01Jan2009, 12:53	0
200	0.000328	0.8	01Jan2009, 12:54	0
201	0.000375	0.9	01Jan2009, 12:54	0
202	0.000094	0.2	01Jan2009, 12:53	0
203	0.000125	0.3	01Jan2009, 12:55	0
204	0.000125	0.3	01Jan2009, 12:54	0
300	0.000281	0.7	01Jan2009, 12:54	0
301	0.000109	0.3	01Jan2009, 12:54	0
302	0.000169	0.5	01Jan2009, 12:53	0
303	0.000101	0.3	01Jan2009, 12:53	0
304	0.000031	0.1	01Jan2009, 12:53	0
305	0.000359	0.8	01Jan2009, 12:57	0
306	0.000291	0.7	01Jan2009, 12:57	0
307	0.000112	0.2	01Jan2009, 12:54	0
308	0.000032	0	01Jan2009, 12:55	0
309	0.000219	0.5	01Jan2009, 12:55	0
Junction-101	0.001672	4.2	01Jan2009, 12:53	0.2
Junction-106	0.002998	6.2	01Jan2009, 12:54	0.3
Junction-108	0.003484	7.3	01Jan2009, 12:54	0.4
Junction-2	0.001047	2.6	01Jan2009, 12:54	0.1
Junction-3	0.001704	3.9	01Jan2009, 12:55	0.2
Junction-301	0.000559	1.4	01Jan2009, 12:53	0.1
Junction-303	0.000491	1.1	01Jan2009, 12:56	0.1
Junction-304	0.000291	0.7	01Jan2009, 12:57	0
Junction-305	0.000403	0.9	01Jan2009, 12:56	0
Junction-307	0.000654	1.4	01Jan2009, 12:56	0.1
Sink-1	0.006235	13.9	01Jan2009, 12:54	0.7

## ATTACHMENT F-4

PROPOSED HYDROLOGIC MODELING OUTPUT  
 STORMWATER MANAGEMENT PLAN  
 ATKEMIX TEN INC.  
 LOUISVILLE, KENTUCKY

## 10-yr Storm Event

<i>Hydrologic Element</i>	<i>Drainage Area (mi<sup>2</sup>)</i>	<i>Peak Discharge (cfs)</i>	<i>Time</i>	<i>Volume (ac-ft)</i>
100	0.000531	1.6	01Jan2009, 12:53	0.1
101	0.000625	1.8	01Jan2009, 12:53	0.1
102	0.000516	1.5	01Jan2009, 12:53	0.1
103	0.000164	0.5	01Jan2009, 12:53	0
104	0.000532	0.6	01Jan2009, 12:57	0
105	0.000078	0.2	01Jan2009, 12:53	0
106	0.000453	1.2	01Jan2009, 12:58	0.1
107	0.000099	0.2	01Jan2009, 12:54	0
108	0.000422	1.2	01Jan2009, 12:55	0.1
109	0.000064	0.2	01Jan2009, 12:53	0
200	0.000328	1	01Jan2009, 12:54	0
201	0.000375	1.1	01Jan2009, 12:54	0.1
202	0.000094	0.3	01Jan2009, 12:53	0
203	0.000125	0.4	01Jan2009, 12:55	0
204	0.000125	0.4	01Jan2009, 12:54	0
300	0.000281	0.8	01Jan2009, 12:53	0
301	0.000109	0.3	01Jan2009, 12:54	0
302	0.000169	0.5	01Jan2009, 12:53	0
303	0.000101	0.3	01Jan2009, 12:53	0
304	0.000031	0.1	01Jan2009, 12:53	0
305	0.000359	1	01Jan2009, 12:56	0.1
306	0.000291	0.8	01Jan2009, 12:57	0
307	0.000112	0.2	01Jan2009, 12:54	0
308	0.000032	0	01Jan2009, 12:55	0
309	0.000219	0.6	01Jan2009, 12:55	0
Junction-101	0.001672	5	01Jan2009, 12:53	0.2
Junction-106	0.002998	7.3	01Jan2009, 12:54	0.4
Junction-108	0.003484	8.7	01Jan2009, 12:54	0.4
Junction-2	0.001047	3.1	01Jan2009, 12:54	0.1
Junction-3	0.001704	4.6	01Jan2009, 12:55	0.2
Junction-301	0.000559	1.7	01Jan2009, 12:53	0.1
Junction-303	0.000491	1.3	01Jan2009, 12:56	0.1
Junction-304	0.000291	0.8	01Jan2009, 12:57	0
Junction-305	0.000403	1	01Jan2009, 12:56	0.1
Junction-307	0.000654	1.7	01Jan2009, 12:56	0.1
Sink-1	0.006235	16.3	01Jan2009, 12:54	0.8

## ATTACHMENT F-4

PROPOSED HYDROLOGIC MODELING OUTPUT  
 STORMWATER MANAGEMENT PLAN  
 ATKEMIX TEN INC.  
 LOUISVILLE, KENTUCKY

## 25-yr Storm Event

<i>Hydrologic Element</i>	<i>Drainage Area (mi<sup>2</sup>)</i>	<i>Peak Discharge (cfs)</i>	<i>Time</i>	<i>Volume (ac-ft)</i>
100	0.000531	2	01Jan2009, 12:53	0.1
101	0.000625	2.3	01Jan2009, 12:53	0.1
102	0.000516	1.9	01Jan2009, 12:53	0.1
103	0.000164	0.6	01Jan2009, 12:53	0
104	0.000532	0.9	01Jan2009, 12:57	0
105	0.000078	0.3	01Jan2009, 12:53	0
106	0.000453	1.5	01Jan2009, 12:58	0.1
107	0.000099	0.3	01Jan2009, 12:54	0
108	0.000422	1.5	01Jan2009, 12:55	0.1
109	0.000064	0.2	01Jan2009, 12:53	0
200	0.000328	1.2	01Jan2009, 12:53	0.1
201	0.000375	1.4	01Jan2009, 12:54	0.1
202	0.000094	0.3	01Jan2009, 12:53	0
203	0.000125	0.4	01Jan2009, 12:55	0
204	0.000125	0.5	01Jan2009, 12:54	0
300	0.000281	1	01Jan2009, 12:53	0
301	0.000109	0.4	01Jan2009, 12:53	0
302	0.000169	0.7	01Jan2009, 12:53	0
303	0.000101	0.4	01Jan2009, 12:53	0
304	0.000031	0.1	01Jan2009, 12:53	0
305	0.000359	1.2	01Jan2009, 12:56	0.1
306	0.000291	1	01Jan2009, 12:56	0.1
307	0.000112	0.3	01Jan2009, 12:54	0
308	0.000032	0	01Jan2009, 12:54	0
309	0.000219	0.8	01Jan2009, 12:55	0
Junction-101	0.001672	6.2	01Jan2009, 12:53	0.3
Junction-106	0.002998	9.2	01Jan2009, 12:54	0.5
Junction-108	0.003484	11	01Jan2009, 12:54	0.6
Junction-2	0.001047	3.8	01Jan2009, 12:54	0.2
Junction-3	0.001704	5.7	01Jan2009, 12:55	0.3
Junction-301	0.000559	2.1	01Jan2009, 12:53	0.1
Junction-303	0.000491	1.7	01Jan2009, 12:55	0.1
Junction-304	0.000291	1	01Jan2009, 12:56	0.1
Junction-305	0.000403	1.3	01Jan2009, 12:56	0.1
Junction-307	0.000654	2.1	01Jan2009, 12:56	0.1
Sink-1	0.006235	20.5	01Jan2009, 12:54	1

## ATTACHMENT F-4

PROPOSED HYDROLOGIC MODELING OUTPUT  
 STORMWATER MANAGEMENT PLAN  
 ATKEMIX TEN INC.  
 LOUISVILLE, KENTUCKY

## 50-yr Storm Event

<i>Hydrologic Element</i>	<i>Drainage Area (mi<sup>2</sup>)</i>	<i>Peak Discharge (cfs)</i>	<i>Time</i>	<i>Volume (ac-ft)</i>
100	0.000531	2.2	01Jan2009, 12:53	0.1
101	0.000625	2.6	01Jan2009, 12:53	0.1
102	0.000516	2.1	01Jan2009, 12:53	0.1
103	0.000164	0.7	01Jan2009, 12:53	0
104	0.000532	1	01Jan2009, 12:57	0.1
105	0.000078	0.3	01Jan2009, 12:53	0
106	0.000453	1.6	01Jan2009, 12:58	0.1
107	0.000099	0.3	01Jan2009, 12:53	0
108	0.000422	1.7	01Jan2009, 12:55	0.1
109	0.000064	0.3	01Jan2009, 12:53	0
200	0.000328	1.4	01Jan2009, 12:53	0.1
201	0.000375	1.5	01Jan2009, 12:54	0.1
202	0.000094	0.4	01Jan2009, 12:53	0
203	0.000125	0.5	01Jan2009, 12:55	0
204	0.000125	0.5	01Jan2009, 12:54	0
300	0.000281	1.2	01Jan2009, 12:53	0.1
301	0.000109	0.4	01Jan2009, 12:53	0
302	0.000169	0.7	01Jan2009, 12:53	0
303	0.000101	0.4	01Jan2009, 12:53	0
304	0.000031	0.1	01Jan2009, 12:53	0
305	0.000359	1.4	01Jan2009, 12:56	0.1
306	0.000291	1.1	01Jan2009, 12:56	0.1
307	0.000112	0.3	01Jan2009, 12:54	0
308	0.000032	0.1	01Jan2009, 12:54	0
309	0.000219	0.9	01Jan2009, 12:55	0
Junction-101	0.001672	6.9	01Jan2009, 12:53	0.3
Junction-106	0.002998	10.4	01Jan2009, 12:54	0.5
Junction-108	0.003484	12.3	01Jan2009, 12:54	0.6
Junction-2	0.001047	4.3	01Jan2009, 12:54	0.2
Junction-3	0.001704	6.4	01Jan2009, 12:54	0.3
Junction-301	0.000559	2.3	01Jan2009, 12:53	0.1
Junction-303	0.000491	1.9	01Jan2009, 12:55	0.1
Junction-304	0.000291	1.1	01Jan2009, 12:56	0.1
Junction-305	0.000403	1.4	01Jan2009, 12:56	0.1
Junction-307	0.000654	2.4	01Jan2009, 12:55	0.1
Sink-1	0.006235	23.1	01Jan2009, 12:54	1.2

## ATTACHMENT F-4

PROPOSED HYDROLOGIC MODELING OUTPUT  
 STORMWATER MANAGEMENT PLAN  
 ATKEMIX TEN INC.  
 LOUISVILLE, KENTUCKY

## 100-yr Storm Event

<i>Hydrologic Element</i>	<i>Drainage Area (mi<sup>2</sup>)</i>	<i>Peak Discharge (cfs)</i>	<i>Time</i>	<i>Volume (ac-ft)</i>
100	0.000531	2.5	01Jan2009, 12:53	0.1
101	0.000625	2.9	01Jan2009, 12:53	0.1
102	0.000516	2.4	01Jan2009, 12:53	0.1
103	0.000164	0.8	01Jan2009, 12:53	0
104	0.000532	1.3	01Jan2009, 12:57	0.1
105	0.000078	0.4	01Jan2009, 12:53	0
106	0.000453	1.9	01Jan2009, 12:58	0.1
107	0.000099	0.4	01Jan2009, 12:53	0
108	0.000422	1.9	01Jan2009, 12:55	0.1
109	0.000064	0.3	01Jan2009, 12:53	0
200	0.000328	1.5	01Jan2009, 12:53	0.1
201	0.000375	1.8	01Jan2009, 12:53	0.1
202	0.000094	0.4	01Jan2009, 12:53	0
203	0.000125	0.6	01Jan2009, 12:55	0
204	0.000125	0.6	01Jan2009, 12:53	0
300	0.000281	1.3	01Jan2009, 12:53	0.1
301	0.000109	0.5	01Jan2009, 12:53	0
302	0.000169	0.8	01Jan2009, 12:53	0
303	0.000101	0.5	01Jan2009, 12:53	0
304	0.000031	0.1	01Jan2009, 12:53	0
305	0.000359	1.6	01Jan2009, 12:56	0.1
306	0.000291	1.3	01Jan2009, 12:56	0.1
307	0.000112	0.4	01Jan2009, 12:54	0
308	0.000032	0.1	01Jan2009, 12:54	0
309	0.000219	1	01Jan2009, 12:55	0
Junction-101	0.001672	7.9	01Jan2009, 12:53	0.4
Junction-106	0.002998	12	01Jan2009, 12:54	0.6
Junction-108	0.003484	14.2	01Jan2009, 12:54	0.7
Junction-2	0.001047	4.9	01Jan2009, 12:53	0.2
Junction-3	0.001704	7.4	01Jan2009, 12:54	0.4
Junction-301	0.000559	2.7	01Jan2009, 12:53	0.1
Junction-303	0.000491	2.1	01Jan2009, 12:55	0.1
Junction-304	0.000291	1.3	01Jan2009, 12:56	0.1
Junction-305	0.000403	1.6	01Jan2009, 12:56	0.1
Junction-307	0.000654	2.7	01Jan2009, 12:55	0.1
Sink-1	0.006235	26.5	01Jan2009, 12:54	1.4



## ATTACHMENT F-5

SWALE 1 DESIGN CALCULATIONS  
STORMWATER MANAGEMENT PLAN  
ATKEMIX TEN INC.  
LOUISVILLE, KENTUCKY

TRAPEZOIDAL CHANNEL ANALYSIS  
RATING CURVE COMPUTATION

June 4, 2009

PROGRAM INPUT DATA	
DESCRIPTION	VALUE
Channel Bottom Slope (ft/ft).....	0.006
Manning's Roughness Coefficient (n-value).....	0.013
Channel Left Side Slope (horizontal/vertical).....	20.0
Channel Right Side Slope (horizontal/vertical).....	20.0
Channel Bottom Width (ft).....	10.0
Minimum Flow Depth (ft).....	0.1
Maximum Flow Depth (ft).....	1.0
Incremental Head (ft).....	0.1

COMPUTATION RESULTS							
Flow Depth (ft)	Flow Rate (cfs)	Flow Velocity (fps)	Froude Number	Velocity Head (ft)	Energy Head (ft)	Flow Area (sqft)	Top Width (ft)
0.1	2.065	1.721	1.0362	0.046	0.146	1.2	14
0.2	7.168	2.56	1.1442	0.1018	0.3018	2.8	18
0.3	15.395	3.207	1.2105	0.1599	0.4599	4.8	22
0.4	27.069	3.76	1.2595	0.2197	0.6197	7.2	26
0.5	42.541	4.254	1.299	0.2812	0.7812	10	30
0.6	62.16	4.709	1.3324	0.3446	0.9446	13.2	34
0.7	86.269	5.135	1.3615	0.4098	1.1098	16.8	38
0.8	115.201	5.539	1.3875	0.4767	1.2767	20.8	42
0.9	149.282	5.924	1.411	0.5453	1.4453	25.2	46
1	188.825	6.294	1.4325	0.6156	1.6156	30	50

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## ATTACHMENT F-5

**CULVERT 2 DESIGN CALCULATIONS  
STORMWATER MANAGEMENT PLAN  
ATKEMIX TEN INC.  
LOUISVILLE, KENTUCKY**

**CIRCULAR CHANNEL ANALYSIS  
RATING CURVE COMPUTATION**

June 3, 2009

PROGRAM INPUT DATA	
DESCRIPTION	VALUE
Channel Bottom Slope (ft/ft).....	0.04
Manning's Roughness Coefficient (n-value).....	0.024
Channel Diameter (ft).....	1.5
Minimum Flow Depth (ft).....	0.1
Maximum Flow Depth (ft).....	1.5
Incremental Head (ft).....	0.1

COMPUTATION RESULTS							
Flow Depth (ft)	Flow Rate (cfs)	Flow Velocity (fps)	Froude Number	Velocity Head (ft)	Energy Head (ft)	Flow Area (sqft)	Top Width (ft)
0.1	0.101	1.993	1.3514	0.0617	0.1617	0.051	0.748
0.2	0.433	3.094	1.4719	0.1488	0.3488	0.14	1.02
0.3	0.996	3.961	1.5248	0.2438	0.5438	0.252	1.2
0.4	1.771	4.68	1.5452	0.3404	0.7404	0.378	1.327
0.5	2.728	5.29	1.5446	0.4349	0.9349	0.516	1.414
0.6	3.835	5.809	1.5282	0.5244	1.1244	0.66	1.47
0.7	5.052	6.248	1.4985	0.6066	1.3066	0.809	1.497
0.8	6.338	6.612	1.4567	0.6795	1.4795	0.959	1.497
0.9	7.645	6.906	1.4027	0.7411	1.6411	1.107	1.47
1	8.92	7.127	1.3357	0.7894	1.7894	1.252	1.414
1.1	10.103	7.274	1.2534	0.8223	1.9223	1.389	1.327
1.2	11.123	7.339	1.1513	0.837	2.037	1.516	1.2
1.3	11.885	7.305	1.0195	0.8292	2.1292	1.627	1.02
1.4	12.238	7.13	0.8299	0.7899	2.1899	1.717	0.748
1.5	0	0	0	0	0	0	0

## COMPUTATION NOTES

\*\*\* Rating Curve terminated at flow depth = 1.500  
Flow depth equals or exceeds channel diameter (1.500)

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